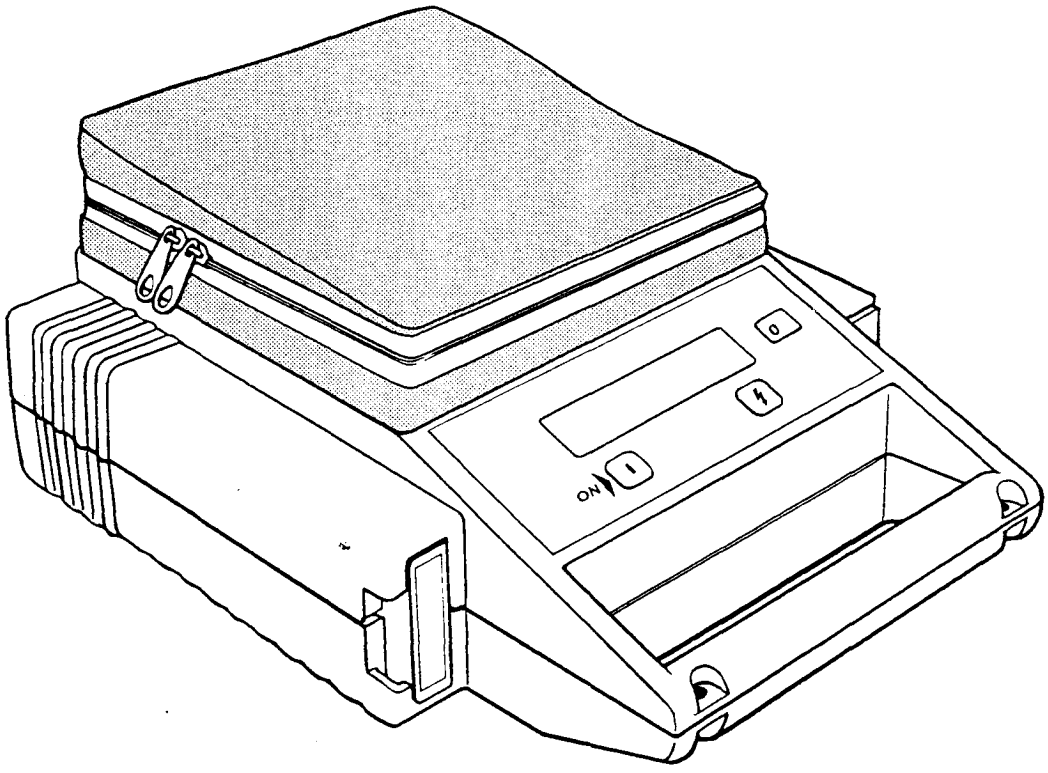
Heartstart® 911

TECHNICAL MANUAL AND

CIRCUIT DIAGRAMS



Laerdal

helping save lives

Table of Contents

1.0	**GENERAL**	**3**
2.0	**TECHNICAL SPECIFICATIONS**	**4**
2.1	Physical Properties	4
2.1.1	Environmental	4
2.1.2	Expected Life and Maintenance	5
2.2.1	Electrodes	6
2.2.2	Patient Cable	6
2.2.3	ECG-Amplifier	6
2.2.4	Electrode Connection Measurement	7
2.2.5	ECG Rhythm Recognition Detector	7
2.3 / 2.4	Defibrillation Circuit	7
2.5.1	Main Microcontroller	8
2.5.2	Program Memory	8
2.5.3	Data Memory	9
2.5.4	Reset Circuit	9
2.5.5	Serial Communication format	9
2.5.6	Real Time Clock Calendar	9
2.5.7	Speech Circuit	9
2.5.8	Beeper	9
2.6.1	I/O-Microcontroller	9
2.6.2	Temperature Measurement	9
2.6.3	Break Detect on Receive Signal	9
2.6.4	Power Reset	9
2.7	Power Supply	10
2.7.1	Battery (new and fully charged)	10
2.7.2	Battery Charger	10
2.7.3	Non-Isolated Section of the Power Supply	11
2.7.4	Isolated Section of the Power Supply	11
2.8	Operation	12
2.8.2	Display	12
2.9	Warning and Error Identifiers	13
2.9.1	Error Detection and Handling	14
2.9.2	Automatic Power Off	17
2.10	Automatic Self tests	17
2.10.1	Testload	18
3.0	**FUNCTIONAL DESCRIPTION**	**21**
3.1	System Overview	20
3.2.1	Electrode Detection System	20
3.2.2	ECG Amplifier	21
3.3	High Voltage Charging Circuit	21
3.4	High Voltage Discharge Circuit	22
3.5	Main Microcontroller Functions	23
3.6	I/O-Microcontroller Functions	25
3.7	Power Supply	26
3.8	Tape Deck	27
4.0	**SERVICE AND MAINTENANCE**	**30**
4.1	Unit Reprogramming	28
4.1.1	Equipment	28
4.2	Calibration	29
4.2.1	Equipment	29
4.2.1	Calibration Procedure	29
4.3	After Service Test	29
4.3.1	Test Equipment	30
4.3.2	Test Procedure	30
5.0	**Mechanical Construction/Parts list**	**31**
6.0	**Schematics**	**36**

1. General

The information provided in this manual is required for checking, maintenance, and repair of the unit. The operating instructions manual provided with every new unit should be consulted for detailed information on use.

Service of the Heartstart 911 should only be performed by Laerdal or organizations authorized by Laerdal. Service performed by others will invalidate the warranty of the device.

WARNING !
When the device is opened, dangerous High Voltages may be accessible. Extreme care should be taken to avoid inadvertent shocking.

WARNING !
Since CMOS-circuits are used for most of the electronics, SPECIAL CARE MUST BE EXERCISED during work with circuit boards and individual circuits. The risk of damage caused by STATIC ELECTRICITY is considerable so procedures for work with CMOS circuits must be SCRUPULOUSLY observed.

Caution!
Do not clean the Heartstart with alcohol, acetone, or other solvents. These cleaning agents may damage equipment surfaces.

2. Technical Specifications.

All values are nominal unless otherwise specified.
Unless stated otherwise, the unit meets the relevant requirements of AAMI DF-39 and IEC601-2-4.

Country version parameters specified are parameters that may vary from country (language) version to country version. These parameters reside in the program memory, and are a part of each language version. They can not be altered by the user nor during unit configuration, but are specified to make it possible to make one generic software version.
It will be possible, though this is not addressed in this specification, to make a Program module where several of these parameters may be altered for individual units.

2.1 Physical Properties:

Weight:	< 4 kg including battery
Size:	351 x 275 x 101 mm (l x w x h) +/- 1 mm
Case material	
Plastic type:	CYCOLOY C2800
Flammability rating:	UL94V0
color:	White
Rubber feet:	
Size:	12.7 x 12.7 x 3.1 mm (l x w x h) +/- 0.2 mm
Carry Strap	
length:	140 cm +/- 10 cm

2.1.1 Environmental:

2.1.1.1 Temperature, Humidity and Pressure.

Operation:	
Temperature	0° C to +50°C
Humidity	5 % to 95% RH non condensing
Pressure	700 kPa to 1060 kPa
Storage (except Battery and Electrodes):	
Temperature	-13° C to +60°C
Humidity	5 % to 95% RH non condensing
Pressure	700 kPa to 1060 kPa

2.1.1.2 Protection Against Liquids

Splash proof — IP code IPX4 in accordance with IEC-529

2.1.1.2.1 Resistance Against Liquids

The case material and label marking are resistant to the following liquids / solvents:
Methylated spirit and Isopropyl alcohol.
1:100 solution of household bleach.

2.1.1.3 Shock Resistance

Non operational	Free fall. Test in accordance with IEC601-1 1988 (21.5)
Height of fall:	1m to 50 mm thick hardwood plate on concrete floor.
	3 falls total, from different attitudes.

Non operational in / out of mounting frame:

Bump. Test in accordance with IEC68-2-29.

Severity:	Bump pulse:	40 g, 6 ms
Directions:		3 perpendicular
Number of bumps:		1000 per direction

2.1.1.4 Vibration

Operational in / out of mounting frame:

Test in accordance with IEC68-2-6.

Severity:	Freq./ Amplitude:	10 -58 Hz: +/- 0.15 mm
		58-150 Hz: 2g
Sweep rate:		1 octave pr. minute
Number of cycles:		20 per axis (3 axes)

Test in accordance with Mil. Std. 810D.

2.1.1.5 Immunity to Radiated EM Fields

Test-method and instrumentation:	IEC-0801-3
Test description and requirement:	AAMI DF-39, section 3.3.21.2.1

2.1.1.6 Immunity to Magnetic Fields

Test description and requirement:	AAMI DF-39, section 3.3.21.2.3

2.1.1.7 Immunity to ESD

Test-method and instrumentation:	IEC-0801-2
Test description and requirement:	AAMI DF-39, section 3.3.21.2.4

2.1.1.8 Electromagnetic Emissions

Comply with	CISPR-11 Level B
Requirement	AAMI DF-39 Section 3.3.21.1.1
	During the charging and discharging these requirements are waived.

2.1.2 Expected Life and Maintenance

Expected life from production date:

HS-911 unit:	8 years, provided regular maintenance is performed and components with lower life expectancy are replaced.

Replacement components:

Clock battery:	5 years
Capacitors:	8 years, or 10000 shocks whichever comes first
Tape recorder mechanism:	5 years

2.1.2.1 Maintenance

Maintenance interval:	1 year recommended
Maintenance should include:	- Cleaning
	- Functional test
	- Test of Energy Accuracy, and calibration
	- Test of ECG amplifier amplification and frequency response
	- Test of Electrode connection system
	- Test of remaining battery capacity

2.2.1 Electrodes

Type:	Self adhesive, Disposable
Patient contact material:	Conductive Polymer
Contact area size (tin):	≥65 cm^2
Contact area size (polymer):	≥80 cm^2
Total outer diameter:	16 cm
Connector:	Laerdal snap terminal
Shelf life:	min. 1 years from delivery date
Storage temperature:	-13°C to 43°C

Otherwise specifications in accordance with AAMI DF-39.

2.2.2 Patient Cable

Conductors:	2 x 0.5 mm^2
Shield:	Spiral wound with > 60% coverage
Dielectric:	1 layer of thermoplastic polyester elastomers
	1 layer of flame-resistant polyurethane
Dielectric strength:	> 10 kV
Flammability outer layer:	UL 94V0
Cable length:	2.3 m +/- 0.3 m
Connectors	
HS-911 end	Custom connector with 3 contacts, patient contacts + shield
Patient	Custom Laerdal snap terminal 2 color coded
	No monitoring electrodes connection.
	Red electrode Apex
	White electrode Sternum

2.2.3 ECG-Amplifier

Input:	2 lead differential input
Red electrode:	+ input
White electrode:	- input
Input signal range:	+/- 2.14 mV nom. differential at 6 Hz
Input signal DC-offset:	+/-0.75 V min.
Input impedance:	536 kΩ at DC
Common mode rejection:	> 50 dB at 5 Hz and 10 Hz
	> 45 dB at 50 Hz and 60 Hz
	Measured at A/D-converter input
DC restore:	< 2 s from saturation until amplifier is within operating range
	(Input DC offset within specification)
Protection	Against 5 kV DC shocks with duration < 100 ms
Energy absorption:	<10% over 100 Ω load per AAMI DF-39, 1993
Leakage currents:	Comply with IEC-601 type BF
Isolation from input to conductive touchable parts:	> 4 kV per IEC-601-2-4

2.2.3.1 ECG-Amplifier and Software Filter Combined:

Digital sampling:

Sample freq.:	100 Hz +/- 1 Hz
Sample size:	8 bits
Zero input :	= 128 +/- 3
Offset Scale:	51 +/- 2 per 1 V input at A/D-converter
Bandwidth	≅1.5 - 27 Hz to -3 dB nominal
Gain	1198 +/-10 % at 6 Hz
Noise rejection	> 30 dB at 50 Hz and 60 Hz

2.2.4 Electrode Connection Measurement

Measurement freq. 2 kHz

Digital sampling:

Sample freq.:	100 Hz +/- 1 Hz
Sample size:	8 bits
Zero input :	= 0 + 2
Scale:	1 V input at A/D = 51 +/- 2

Limits for shock delivery:
(Resistive values do not relate directly to patient impedance)

Low limit:	Sample value: 06	Resistive value: 15 Ω min
High limit:	Sample value: 222	Resistive value: 855 Ω max

Disconnected electrodes: See 2.9.2 for Auto Power off condition

2.2.5 ECG Rhythm Recognition Detector

Type: Software based

Shockable ECG:

Ventricular Fibrillation:	amplitude ≥ 200 µV p-p
Ventricular Tachycardia:	QRS rate ≥ 180 bpm

Specificity:	Comply with AAMI DF-39 section 3.3.18
Sensitivity:	Comply with AAMI DF-39 section 3.3.18
Maximum analysis time:	9 seconds
Shock criteria:	6 out of 9 seconds of ECG diagnosed shockable
"Press to Analyze" criteria:	9 out of 12 seconds of ECG diagnosed shockable

2.3 / 2.4 Defibrillation Circuit

Waveform type:	Truncated exponential per AAMI/ANSI DF-2-1989
Available energies:	200J, 300J, 360J
Energy accuracy:	
50 Ω:	+/- 15%
25 Ω - 250 Ω:	+/- 30%
Calibration 360 J , 50 Ω:	+/- 5% at room temperature

Nominal Capacitor voltages depending on calibration. (Temperature = 15°C to 50°C):

360 Joules (Volt)	300 Joules (Volt)	200 Joules (Volt)	Corresponding Capacitance(μF)	Calibration Group
2103	1945	1650	198	1
2085	1929	1637	202	2
2067	1913	1624	206	3
2048	1896	1610	211	4
2030	1880	1598	215	5
2012	1864	1585	220	6
1994	1847	1572	224	7
1976	1831	1559	229	8
1957	1814	1546	235	9
1939	1798	1533	240	10
1921	1782	1520	245	11
1903	1765	1508	251	12
1884	1748	1494	257	13
1866	1732	1482	263	14
1848	1716	1469	269	15

Temperature compensation: + 0 to + 90 V between 15°C and 2.5 °C Nominal
≅ 7 V / °C in 9 V increments

Over voltage detection: OVERV: 2350 V nom

Truncation voltage (end voltage): 750 V nom. 1100 V max

Nominal Shock length into 50 Ω:
- 200 J: 10 ms
- 300J: 12 ms
- 360J: 13 ms

Maximum shock length: 40 ms

Capacitor size: 220 μF +20 % / - 10%
2250 V, (5 x 1100 μF, 450 V)

Charging time to 360 J: 10 s nominal with new fully charged battery
Charging time-out: 20 s from start of charge
Shock delivery time-out: 15 seconds from charging ready

Endurance: 10.000 shocks or 8 years, whichever comes first
Max. number of shocks per hour: 50 at temp. 50°C, 100 at temp. < 40 ° C
Max. number of shocks per. week: 1000

Calibration: Start voltages for each energy and end voltage shall be stored in the EEPROM of the I/O-microcontroller.

Shock polarity: Positive: Red electrode
Negative: White electrode

2.5.1 Main Microcontroller

Processor type: I80C188XL
Clock crystal frequency: 19.6608 MHz

2.5.2 Program Memory

Memory type:	Flash EPROM
Size:	128 k bytes

2.5.3 Data Memory

Memory type:	Static RAM
Size:	32 k bytes
Data retention: turned off.	Battery backup. Data is maintained when power is

2.5.4 Reset Circuit

Power reset: /RESET (TP305):	Typ. 4.65 V
Watchdog time-out period:	1 s min., 2.25 s max
/RESET pulse width:	35 ms min., 70 ms max

2.5.5 Serial Communication Format

Bi-directional Asynchronous Serial Communication.

Baud rate:	19200
Format:	1 start bit, 8 bits data, 1 stop bit

2.5.6 Real time Clock Calendar

Clock and calendar:	seconds, minutes, hours, day, month, year, leap-year
Accuracy:	+/- 40 ppm which is +/- 22 minutes / year

2.5.7 Speech Circuit

Volume adjustments	Low volume (SPVOL1(high), SPVOL2(high) Med. volume (SPVOL1(low), SPVOL2(high High volume (SPVOL1(low), SPVOL2 = (low)

2.5.8 Beeper.

Amplitude SPEECH+/SPEECH- :	1.52 Vpp 1.75 +/- 0.3 V Vp-p (BEEP (TP302) = 1200 Hz, Output load = 8.25 Ω).

2.6.1 I/O-Microcontroller.

Processor type:	TMS370C742FN
Clock crystal frequency:	19.6608 MHz
Program memory (OTP):	8K bytes
Data memory (RAM):	256 bytes
Non volatile memory (EEPROM):	256 bytes
A/D-converter:	8 channels, 8 bit

2.6.2 Temperature Measurement:

Temperature measurement accuracy:	+ 6°C / -4°C (Temp = 0 to 25° C) +/- 8° C (Temp = 26° to 50° C)

2.6.3 Break Detect on Receive Signal

Reset (TP203 = low):	< 10 ms from U-204 RXD (42) logic low

2.6.4 Power Reset

+VCC high:	5.5 V min. 6.0 V max (U202-A)
+VCC low:	4.5 V min. 4.6 V max (U205)

2.7 Power Supply

2.7.1 Battery (new and fully charged)

Battery type:	Rechargeable sealed lead-acid Panasonic LCS-2012VBNC
Nominal Voltage:	12 V
Capacity:	2 Ah
Recharges:	>200 nominal
Expected life:	2 years nominal
Operating capacity:	≥ 20 shocks of 360 J at temperatures > 0° C
Internal impedance:	< 101 mΩ at 25° C, 1000 Hz
Self-discharge rate:	< 54 % over 1 years at 25° C
Weight:	approx. 700g
Size:	200 x 62 x 25 mm
Recommended storage and recharge temperature:	5 - 30° C, (0 - 40° C max.)

2.7.1.2 Current Consumption

Normal operation wo/tape	(V = 13V) 175 mA max.
Normal operation w/tape	(V = 12V) 350 mA max.
Charging	(V = 10.5V) 11 A max.

2.7.1.3 Battery Low Alarms

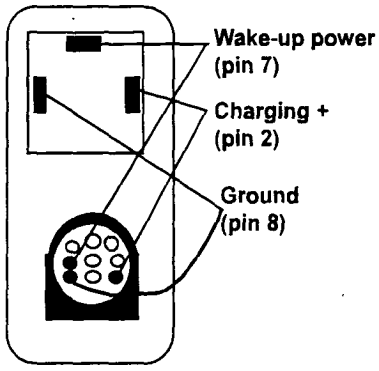
"Battery low" warning:	When capacity < 4 shocks for new batteries. Battery voltage < 11.8 V +/- 0.2 V no charging or Battery voltage < 9,8 V +/- 0.2 V during charging. Indicated by "Battery low" displayed warning. Operation continues.
"Replace battery" warning:	When 4 shocks has been delivered after "Battery low" warning. Indicated by "Replace Battery " displayed and "Replace battery" voice prompt repeated every 15 seconds. Operation continues.
Automatic shutoff:	When capacity < 1 shock. Battery voltage < 8.6 V +/- 0.2 V, or time-out after "Battery low" given. See 2.9.2 .

2.7.2 Battery Charger

Connectors:	Charging connector Mounting bracket connector

Unit charging connectors

Seen from back of HS-500



Charging +	Charging connector pin
Fast charge:	Constant current
Battery Voltage:	< 14.8 V +/- 0.2V @ 25 °C
Current:	800 mA max
Float charge:	Constant voltage
Voltage:	13.7 V +/- 0.1 V @ 25 °C
Wake-up power	Power for display and wake up function.
Voltage:	12 V +/- 3V
Current:	15 mA max
Supply voltage:	120 V AC, 60 Hz
	230 V AC, 50 Hz
Classification:	Class II in accordance with IEC-601

2.7.3 Non-Isolated Section of the Power Supply

+VB (TP64):	16.0 V max, 7.0 V min
	The above values reflect operational electronics.
+VBSW (TP66):	>=+VB - 0,4 V No charging
+5V (TP67) :	5.15V +/- 0.15V
Current capacity	1 A
VREF (TP75)	+2.5 V +/- 0.05 V
RAM backup power: VBB (TP306)	3.1 V nom., 2.5 V min, 3.5 V max
Lithium battery capacity.	500 mAh
Logic supply voltage +5V	+5.1 V
Display power supply. VLCD	4.75 +/- 0.15 V
Current	10 mA max
EPROM progr. supply. Vpp	+12 V +/- 5%
Current Ipp	30 mA max

2.7.4 Isolated Section of the Power Supply

+7 V (TP58):	+7.25 V +/- 0.75 V
-7 V (TP57):	-7.35 V +/- 0. 85 V
+VCC (TP 54):	+5.0 V +/- 0.5 V
+ 5VREF (TP15):	+5. 00 V +/- 0 .05 V
IGBTP-IGBTN:	17.75 +/- 1.25 V

2.8 Operation

2.8.1 Keyboard

Type of keyboard:	Membrane with tactile feedback
Key activation force:	>3N
Number of keys:	3
Keyboard size:	67 x 178 mm +/- 0.2 mm
Display window size:	97 x 22 mm +/- 0.2 mm
Display window material:	1 mm polycarbonate with Nitto AG20 antiglare film
Endurance:	10^6 operations min. / key

2.8.2 Display

Display type:	LCD character display 16 char. x 2 lines
Physical size:	122 x 44 x 14.5 mm (l x w x h)
Color:	Gray
Viewing area size:	99 x 24 mm
Character size:	8.3 x 4.8 mm + cursor
Character font:	5 x 7 dots + cursor
Backlight:	LED, Yellow
Power consumption:	(Vcc = 5V) 2 mA typ
Power consumption LED backlight:	200 mA max

2.8.2.1 Display messages

See Directions for Use.

2.8.3 Voice Messages

See Directions for Use.

2.8.4 Beeper

Unit on:	Freq.: 2400 Hz, Duration 1 second
Beep during analysis:	Freq.: 1200 Hz, Duration: 0,5 sec. ON / OFF
Charging beeper:	Frequency proportional to capacitor volt Min.: 100 Hz, Max.: 2000 Hz
Beep after illegal key-pressure:	Freq.: 2400 Hz, Duration: 0.3 sec
Beep at Error messages, "Battery low" and Service messages:	2 tone, 784 Hz, Duration: 0.1 sec 988 Hz, Duration: 0.3 sec
Automatic selftest turn on:	Freq.: 2400 Hz, Duration 1 second
Automatic selftest error indication:	2 tone, every 5 seconds 784 Hz, Duration: 0.1 sec 988 Hz, Duration: 0.3 sec
Beep at "Service mandatory":	1200 Hz, continuous
Beep preceding speech messages:	Freq.: 900 Hz, Duration: 0.5 sec

2.9 Warning and Error Identifiers

The warning / error identifier consists of a text and a warning / error code number. This code number is the same for all language versions. For warning / error codes and definitions, see section 2.3.1

Warning /Error Code	Display Text.	Defined in Section.
02	CHARGER 02	2.9.1.2
03	I/O-PROC. 03	2.9.1.2
04	DISCHARGE 04	2.9.1.3
05	ENERGY LOW 05	2.9.1.3
06	ENERGY HIGH 06	2.9.1.3
07	DISCHARGE 07	2.9.1.3
13	DUMP RELAY 13	2.9.1.1 / 2.9.1.4.2
14	I/O-PROC. 14	2.9.1.4.4
15	COMMUNIC. 15	2.9.1.1
16	SHOCK COUNT 16	2.9.1.4.5
17	I/O-PROC. 17	2.9.1.4.4
21	COMMUNIC. 21	2.9.1.4.3
22	COMMUNIC. 22	2.9.1.4.3
31	VOLT HIGH 31	2.9.1.4.1
32	VOLT LOW 32	2.9.1.4.1
33	VOLT HIGH 33	2.9.1.4.1
34	VOLT LOW 34	2.9.1.4.1
35	VOLT HIGH 35	2.9.1.4.1
36	VOLT LOW 36	2.9.1.4.1
41	RAM FAIL 41	2.9.1.1
42	ROM FAIL 42	2.9.1.1
43	CPU FAIL 43	2.9.1.1
44	TIMER FAIL 44	2.9.1.1
45	KEYBOARD 45	2.9.1.1
46	RTC-CLOCK 46	2.9.1.1
47	MCM BATT.LOW 47	2.9.1.1
48	MCM FULL	See Directions for Use
49	INT. MEM. FULL	See Directions for Use
50	TESTLOAD 50	2.10.1.1
52	EXT. CHRG. 52	2.9.1.1
53	RTC-CLOCK 53	2.9.1.1
60	not displayed, MCM only	2.9.1.4.4
61	not displayed, MCM only	2.9.1.4.4
81	CHARGER 81	2.9.1.2
82	CHARGER 82	2.9.1.2
83	CHARGER 83	2.9.1.2
88	ENERGY HIGH 88	2.9.1.3

89	DISCHARGE 89	2.9.1.3
92	CHARGER 92	2.9.1.2
93	CHARGER 93	2.9.1.2
94	CALIBRATION 94	2.9.1.1, 2.9.1.4.4
95	I/O-PROC. 95	2.9.1.1
96	I/O-PROC. 96	2.9.1.1
97	I/O-PROC. 97	2.9.1.1
98	I/O-PROC. 98	2.9.1.1
99	CHARGER 99	2.9.1.2

2.9.1 Error Detection and Handling.

Errors detected result either in a Warning which allows operation of the unit to continue, or a Service Mandatory message which will shut the operation of the unit down. Under the Warning / Mandatory column it is indicated whether an error is a Warning or a Service Mandatory error. If both are listed, the device will first issue a Warning and then if the error repeats itself on the next trial, go to Service Mandatory. The Warnings and Mandatory errors are also annotated in the MCM and Internal Memory as "WARN. 'error code'" or "SM. 'error code' "

2.9.1.1 At start-up:

Error Type:	Error Code	Error Criteria	Detected by	Warning / Mandatory
CPU test error	95	I/O-microcontroller CPU test fail.	I/O-proc.	Mandatory
Timer test error	96	I/O-microcontroller timer test fail.	I/O-proc.	Mandatory
RAM test error	97	I/O-microcontroller data memory fail.	I/O-proc.	Mandatory
EPROM checksum error	98	I/O-microcontroller program memory checksum fail.	I/O-proc.	Mandatory
EEPROM CRC error	94	I/O-microcontroller Calibration parameters CRC fail.	I/O-proc. Main Proc.	Warning
RAM test error	41	Main-microcontroller data memory fail.	Main-proc.	Mandatory
EPROM checksum error	42	Main-microcontroller program memory checksum fail.	Main-proc.	Mandatory
CPU test error	43	Main-microcontroller CPU test fail	Main-proc.	Mandatory
Timer test error	44	Main-microcontroller timer test fail.	Main-proc.	Mandatory
I/O-proc-download	15	Error in downloading I/O-microcontroller EEPROM data	Main-proc.	Warning
Keyboard	45	"Shock"-key active at power on.	Main-proc.	Warning
Real-time-clock	46	Error in RTC data, unable to read RTC, RTC stopped	Main-proc.	Warning
Real-time-clock Battery	53	RTC battery is low.	Main-proc.	Warning
MCM-battery low	47	The battery in the inserted MCM has too low voltage.	Main-proc. / MCM	Warning
Dump relay	13	Dump relay not closed, VCAP >= 100 V at start-up.	Main-proc.	Mandatory
Charger Connected	52	The charger is connected when the unit has been turned on by the ON-key	Main-proc.	Warning

2.9.1.2 During Charging:

Error Type:	Error Code	Error Criteria	Detected by.	Warning / Mandatory
Over voltage	81	OVERV detected.	I/O-proc.	Warning Mandatory
charge-not-reached	82	Nominal capacitor voltage not reached within 22 seconds.	I/O-proc.	Warning Mandatory
shock-not-given	83	Shock not given within 17 seconds from capacitors are charged. (Main micro-controller shall abort shock after 15 seconds.)	I/O-proc.	Warning Mandatory

charging-ratio-error	92	VCAP does not reach 500 V in 3 seconds.	I/O-proc.	Warning Mandatory
charging-ratio-error	99	VCAP larger than 1400 V in 3 seconds.	I/O-proc.	Warning Mandatory
charging-volt-drop-detect-error	93	VCAP voltage falls during charging. VCAP < VCAP-max/2.	I/O-proc.	Warning Mandatory
charge-not-reached	02	Nominal capacitor voltage not reached within 20 seconds.	Main-proc.	Warning Mandatory
charge-command-time-out	03	The I/O-microcontroller has not responded on charging command within defined time.	Main-proc.	Warning Mandatory

2.9.1.3 Before or During Shock Delivery:

Error Type:	Error Code	Error Criteria	Detected by	Warning / Mandatory
Truncate-error	88	IGBT R_{OFF} < 30 MΩ. $VCAP_{TRUNC} < VCAP_{END}/4$.*	I/O-proc.	Warning
Voltage-not-dropping	89	VCAP has not dropped below 1100V in 40 ms	I/O-proc.	Warning Mandatory
Shock-not-delivered	04	VCAP > Start-voltage - 500 V after shock delivery.	Main-proc.	Warning Mandatory
Energy low	05	VCAP < Start-voltage - 90 V before shock is delivered.	Main-proc.	Warning
Energy high	06	VCAP > Start-voltage + 90 V before shock is delivered.	Main-proc.	Warning Mandatory
Too-long-discharge	07	I/O-microcontroller does not come out of discharge within defined time.	Main-proc.	Warning Mandatory

2.9.1.4 System Surveillance.

2.9.1.4.1 Isolated Voltage Monitoring:

Error Type:	Error code	Error Criteria	Detected by	Warning / Mandatory
+7V HIGH	31	+7V >= 8.0 V	Main-proc.	Mandatory
+7V LOW	32	+7V <= 6.5V	Main-proc.	Mandatory
-7V HIGH	33	-7V >= -6.5V	Main-proc.	Mandatory
-7V LOW	34	-7V <= -8.0 V	Main-proc.	Mandatory
+VCC HIGH	35	+VCC >= 5.5 V	Main-proc.	Mandatory
+VCC LOW	36	+VCC <= 4.5 V	Main-proc.	Mandatory

Error is indicated if the average voltage over one second exceeds the specified limits.

2.9.1.4.2 Dump Relay Monitoring:

Error Type:	Error code	Error Criteria	Detected by	Warning / Mandatory
Dump relay	13	Dump relay not closed, VCAP >= 100 V after charging or discharge.	Main-proc.	Warning

*$VCAP_{TRUNC}$ = *VCAP after truncation of waveform.*
$VCAP_{END}$ = *VCAP before truncation of waveform.*

2.9.1.4.3 Communication Monitoring:

Error Type:	Error code	Error Criteria	Detected by	Warning / Mandatory
Communication / Checksum test	21	Communication error detected by communication circuit, or Checksum error on received message from I/O-microcontroller, or Time between received messages < 8 ms or > 12 ms, or Error in received test byte.	Main-proc.	Warning
I/O-microcontroller-halted	22	No valid message is received for 100 ms, or test byte has been incorrect on consecutive messages for 100 ms.	Main-proc.	Warning / I/O proc. reset. Mandatory

- Ignore messages with communication and checksum errors.
- Count up communication / checksum / timing /test byte errors and give warning if count >1 in one second.
- If I/O-microcontroller-halted, reset I/O-microcontroller by sending break.

2.9.1.4.4 Main and I/O-Microcontroller State Monitoring:

Error Type:	Error code	Error Criteria	Detected by	Warning / Mandatory
Main-proc. state error	60	State variable is incorrect	Main-proc.	Unit off
Main-proc. task error	61	Task control variable is incorrect	Main-proc.	Unit off
I/O-proc-state-error	14	I/O-microcontroller is not in monitoring state when it should be.	Main-proc.	Warning Mandatory
I/O-proc. ECG sampling error	17	I/O-microcontroller is not sampling on ECG channel 1	Main-proc.	Warning Mandatory
EEPROM CRC error	94	I/O-microcontroller Calibration parameters CRC fail after shock delivery.	I/O-proc. Main Proc.	Warning

For error codes 14 and 17, reset I/O-microcontroller by sending break.

2.9.1.4.5 Shock Count Monitoring:

Error Type:	Error code	Error Criteria	Detected by	Warning / Mandatory
Shock count	16	Shock count exceeds 50 shocks in one hour.	Main-proc.	Warning

2.9.2 Automatic power off:

The unit will turn itself off automatically under the following conditions:

State	Time-out	Condition	Action
Set-up	2 minutes	No keyboard activity	Unit is turned off, no warning
Attach Electrodes	2 minutes	Electrodes have not been attached.	"Attach Electrodes" voice during time-out period. "AUTO OFF" annotated in MCM and Internal Memory. "AUTO OFF" displayed. Unit is turned off.
Battery Low or Replace Battery	10 minutes	"Battery low" or "Replace Battery" warning has been given, and there has been no keyboard activity or any change in electrodes state over the time-out period.	"Replace battery" voice prompt. "AUTO OFF" annotated in MCM and Internal Memory. "AUTO OFF" displayed. Unit is turned off. See also 2.7.1.3
Battery fail	Immediate	The battery voltage is below shutoff limit (see 2.7.1.3).	"Replace battery" voice prompt.. "BAT.FAIL" annotated in MCM and Internal Memory. "AUTO OFF" displayed . Unit is turned off. See also 2.7.1.3
When unit is on	30 minutes	There has been no keyboard activity or any change in electrodes state over the time-out period.	Warning beep. "AUTO OFF" annotated in MCM and Internal Memory. "AUTO OFF" displayed. Unit is turned off.
Service Mandatory	2 minutes	Service Mandatory	Continuous beep in this state Unit is turned off without any other warning. "AUTO OFF" annotated in MCM and Internal Memory.
Main Proc. State error	Immediate	See 2.9.1.4.4	Unit turns itself off immediately. Warning annotated in MCM and Internal Memory.

2.10 Automatic Self tests:

The following tests are performed:

- Start-up tests described in 2.9.1.1
    - Exception: Error code 52 not performed.
- Isolated voltage monitoring described in 2.9.1.4.1
- Communication monitoring described in 2.9.1.4.3
- I/O-processor state monitoring described in 2.9.1.4.4
- Battery voltage monitoring described in 2.7.1.3
    - "Battery low" = warning
    - "Shut-off" = Service Mandatory
- Identify test load.
- Error code 50

If testload is connected the following tests are performed:

- Charge to 1000 V. Perform tests described in 2.9.1.2:
  Exceptions:
  - Error code 82, time-out is 6 seconds.
  - Error code 02, time-out is 5 seconds.
  - Error code 99, charge time is less than 2 seconds.
- Deliver 50 J shock into testload. Update shock count.
  Perform tests described in 2.9.1.3:
  Exceptions:
  - Error code 89, is not performed.
  - Error code 04, shock time < 4ms, or > 12 ms.
- Test dump relay as specified in 2.9.1.4.2

Tests are performed until a Service Mandatory condition is found.

"Service Mandatory" condition:
Stop further testing
Log error in MCM and Internal Memory
Indicate error on display
Signal error result to charger
Keep power on, and give beep-beep every 5 seconds

"Warning condition":
Log warning in MCM and Internal Memory
Continue testing
When test is finished
Indicate warning on display
Signal error result to charger
Keep power on, and give beep-beep every 5 seconds

If more than one warning occurs, all warnings are logged in the MCM and Internal Memory, but only the last occurring is displayed.

2.10.1 Testload:

Resistance:	100 Ω +/- 5%
Voltage:	1100V max
Effect:	50 J over 8 ms pulse

2.10.1.1 Testload Identification

All the following criteria must be fulfilled to accept a connected testload:

2 kHz Electrode detection value:	25 - 39
ECG algorithm result:	Asystole
Baseline of ECG:	125 - 131
P-P ECG (45 Hz ELEC freq.):	24 - 70

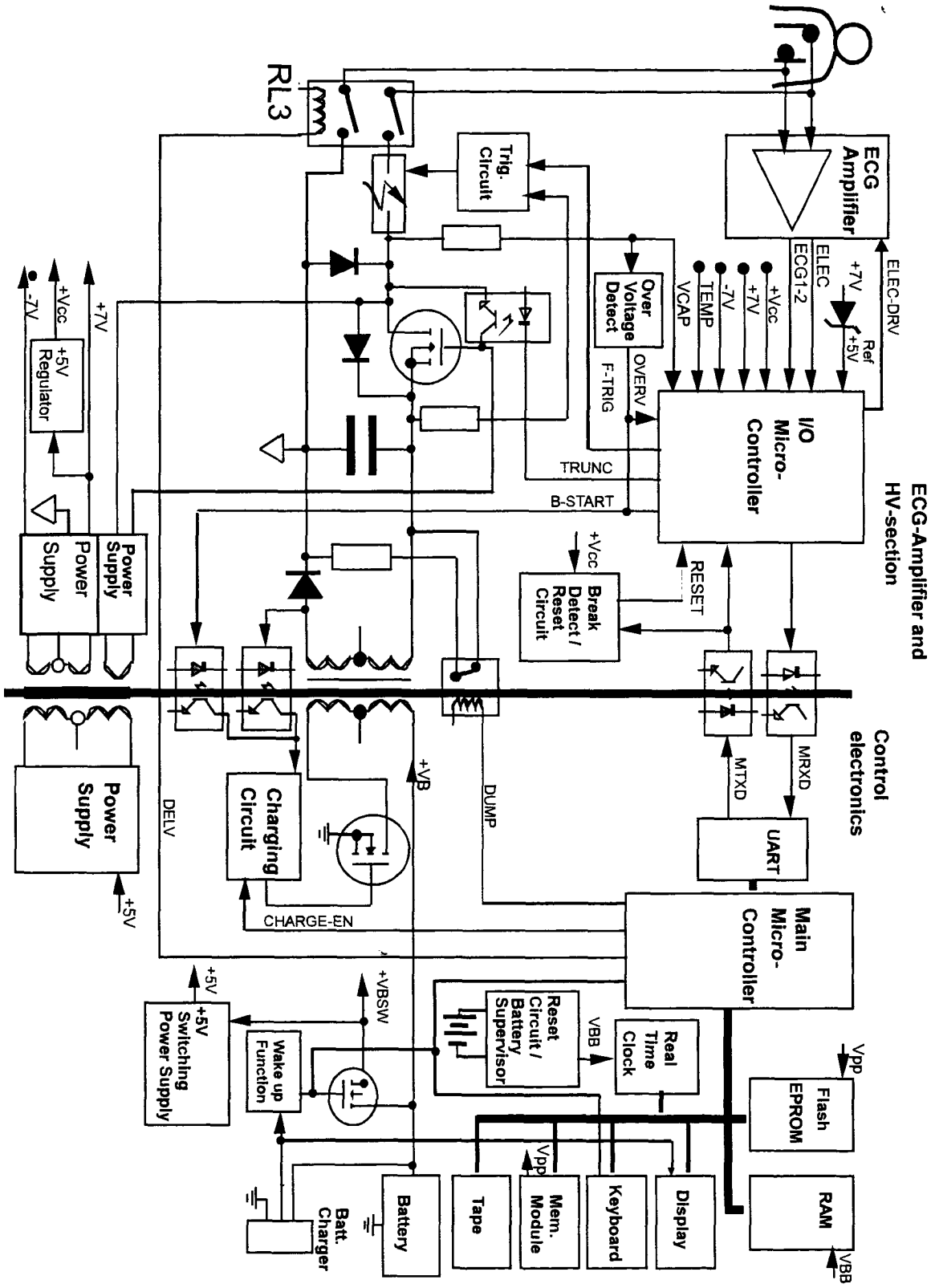


Fig. 3.1 HS-911 BLOCK DIAGRAM

3.0 Functional Description

3.1 System Overview

Figure 3.1 gives a complete overview of the Heartstart 911 hardware functions. The HS-911 has two microcontrollers, the Main microcontroller which is the main controller for the device, and the I/O microcontroller which controls the ECG and electrode signal acquisition, and the shock delivery components. The Main microcontroller is placed on the non-isolated side, while the I/O-microcontroller is placed on the isolated patient side. The two microcontrollers communicate over a serial link, through opto-couplers.

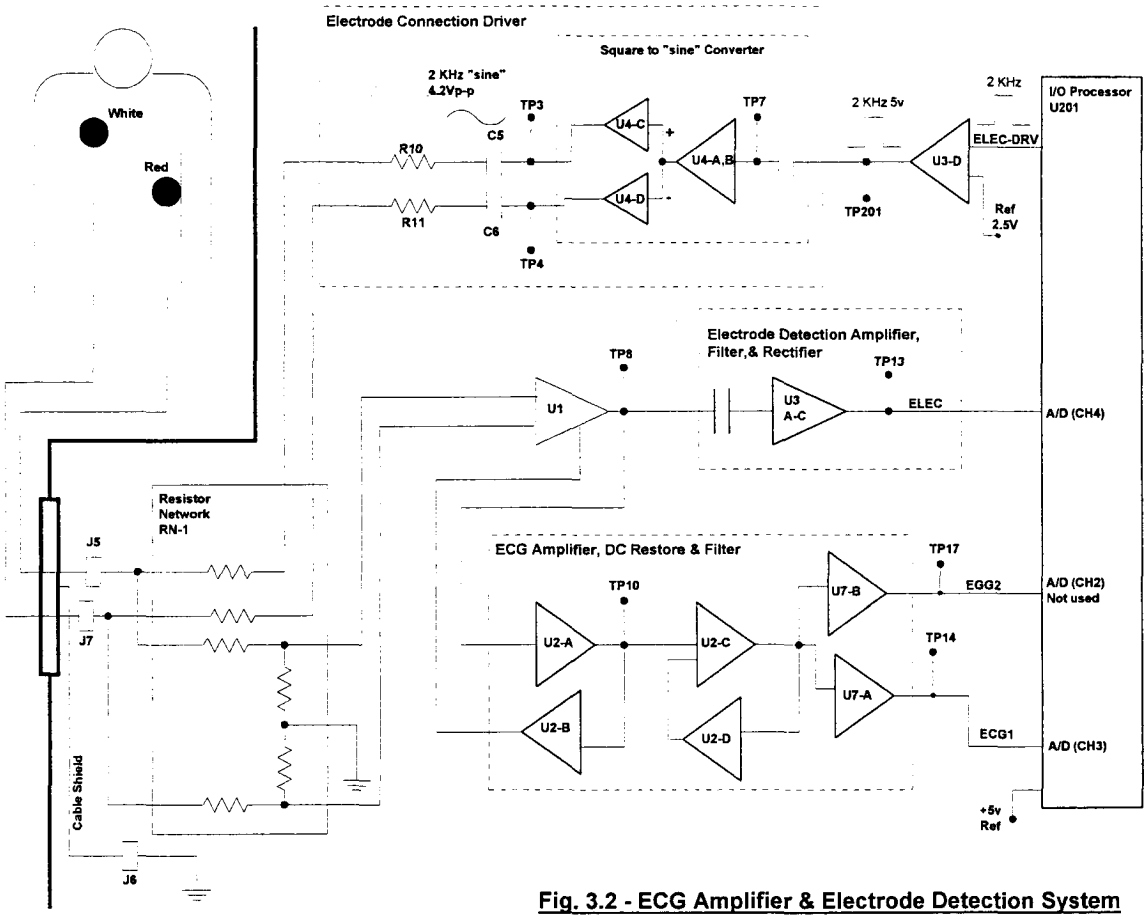


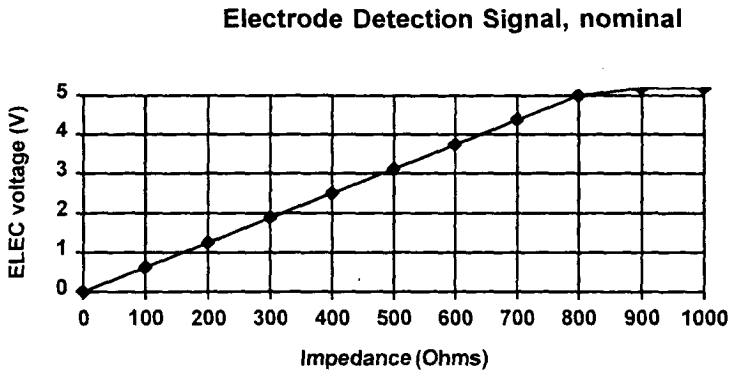
Fig. 3.2 - ECG Amplifier & Electrode Detection System

3.2.1 Electrode Detection System

See figure 3.2 and FPS1328 electrical schematic, page 3

The purpose of the electrode detection system is to detect that defibrillation electrodes are attached to a patient. The electrode connection is detected by a 2 kHz AC signal. This signal is generated as a square wave from the I/O-microcontroller. It passes through the comparator U3-d to get a correct amplitude. The square wave is then converted to a sine wave in U-4 and output as a bi-polar signal to the patient through the resistors R10/R11 and the resistor network RN1. RN1 is a high voltage resistors network which will protect the circuitry from the shock voltage together with the protection diodes on the inside of RN1 and R10 / R11.

The return signal is amplified together with the ECG in U-1 before it is filtered and amplified in U3-a to U3-c. The end-signal ELEC (TP13) is read by the I/O-microcontroller A/D-converter, channel 4. See Technical specification for valid electrode detection limits.



3.2.2 ECG Amplifier

See figure 3.2 and FPS1328 electrical schematic, page 3

The ECG signal from the patient goes through the resistor network RN1 which protects the ECG amplifier from shock voltages, together with the protection diodes on the inside of RN1 and R3/R4.

The resistors of RN1 are matched to 0.1% to maximize common mode rejection.

The ECG is amplified in the front end amplifier U-1 together with the Electrode Detection signal.

The ECG signal is then amplified and filtered in U2-A, U2-C and U7-A.

U2-B generates DC-restore signal feedback to U-1 to compensate for DC-offsets on the patient.

U2-D generates DC-restore signal feedback to U2-C.

The amplified ECG signal ECG1(TP14) is read by the I/O-microcontroller A/D-converter, channel 3. ECG2(TP17) has the double amplitude of ECG1. This signal is not in use at the present time, but can be sampled by the I/O-microcontroller A/D-converter channel 2.

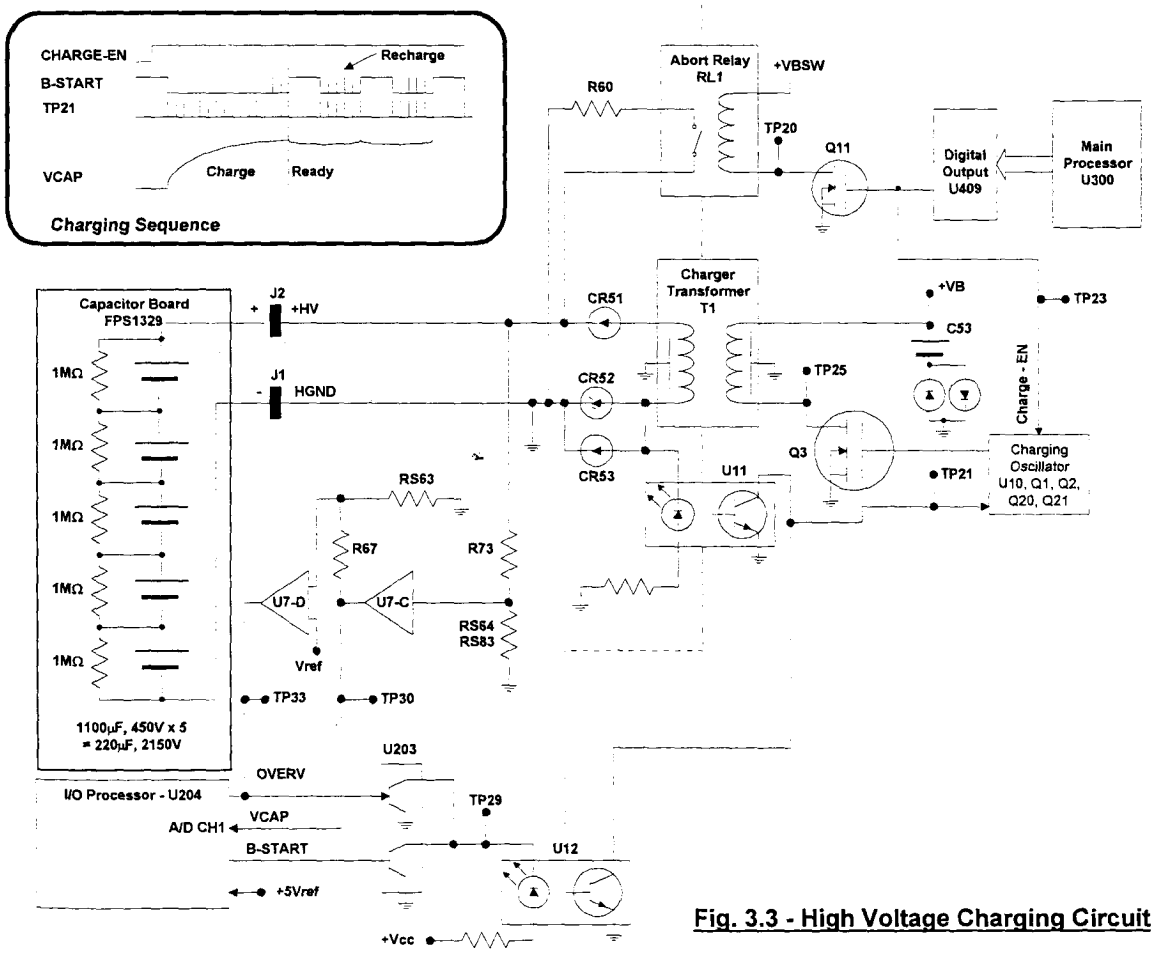


Fig. 3.3 - High Voltage Charging Circuit

microcontroller enabling charging with the CHARGE-EN line, which also deactivates the Abort relay. The Main microcontroller will then send a charge command via the serial communication to the I/O-microcontroller, which will start the charger by bringing the B-START line low. The charging oscillator is now self sustained with feedback through the opto-coupler U11.

During charging the I/O-microcontroller will monitor the VCAP line, and when VCAP has risen to the desired voltage, charging is turned off by setting the B-START line high.
The capacitor voltage is maintained by monitoring the VCAP line and periodically restarting the charger to refresh the capacitors. During this refresh the charger is turned off and on at a 50 Hz frequency, to minimize noise to the ECG.

The software generated tone during charging have a frequency proportional to the voltage on the capacitors.

The desired voltage level on the capacitors is dependent on the desired energy, and the calibration of the unit, see section 2.5. The voltage value resides in the EEPROM of the I/O-microcontroller, and can be changed through calibration, using the "Calibration MCM". For cold temperatures the voltage level is increased to compensate for capacitor loss, see section 2.5
If the I/O-microcontroller is unable to turn the charger off, the OVERV signal will activate when the voltage is above 2350V, and turn the charger off.

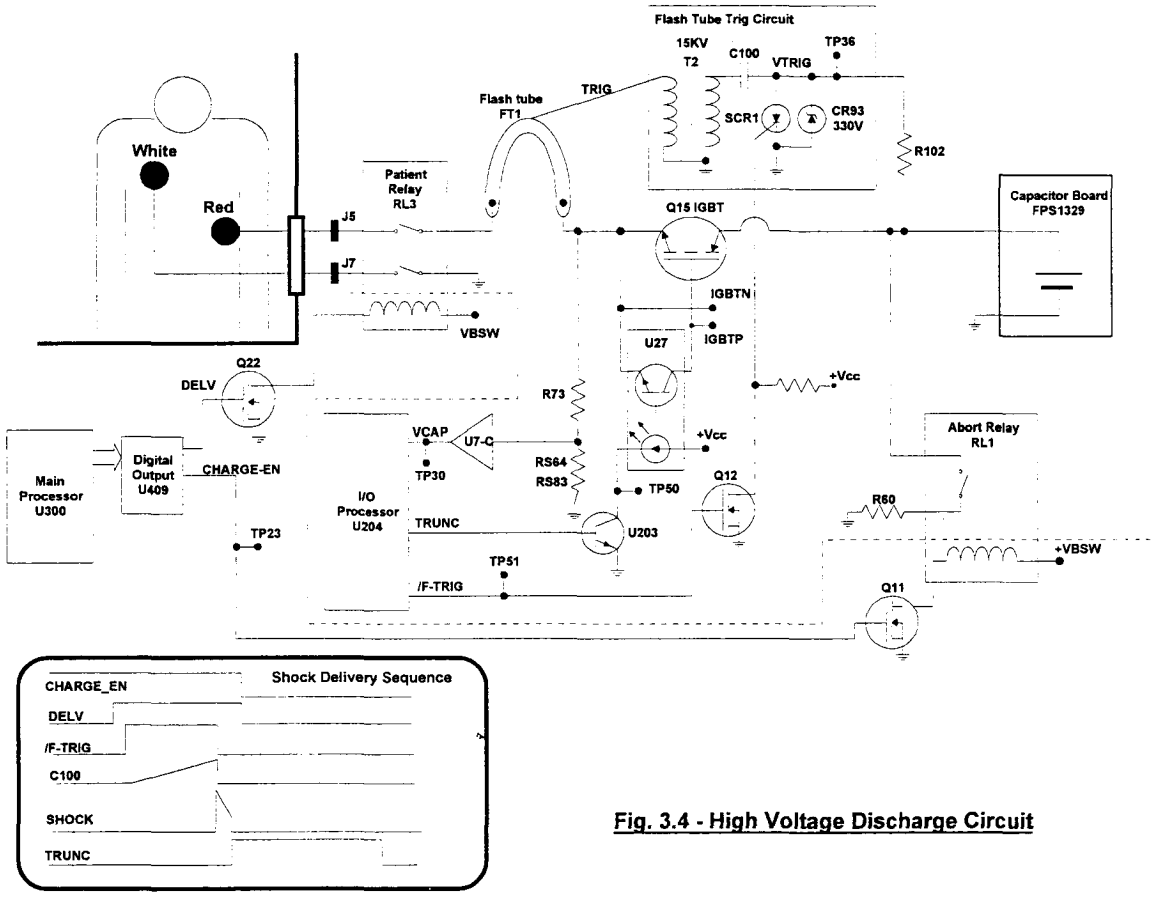


Fig. 3.4 - High Voltage Discharge Circuit

3.4 High Voltage Discharge Circuit

See figure 3.4 and FPS1328 electrical schematic, page 4.
There are three switching elements used to discharge the shock. The patient relay RL3 together with the flashtube FT1 is used to isolate the HV-parts from the patient. RL3 is an open-air relay, intended for cold switching of the shock. This relay is controlled by the Main microcontroller. The flashtube FT1 is used to start the shock. It is controlled by the I/O-microcontroller. The IGBT Q15 is used to truncate the shock. The operating voltage of the IGBT is less than the nominal start voltage of the shock, so the IGBT is always kept in the on-state during charging and discharge. When the shock has reached its truncation voltage, 750 V, the shock is turned off by Q15, controlled by the I/O-microcontroller.
Shock delivery sequence: The Main microcontroller activates the patient relay RL-3, and signals to the I/O-microcontroller to deliver the shock. The I/O-microcontroller then activates the /F-TRIG line for 150 ms to charge up the trigger circuit capacitor C100 to approximately 300 V. When /F-TRIG goes low again, the flash tube is triggered, and the

shock is released. During the shock, the I/O-microcontroller monitors the voltage on the capacitors, and truncates the shock by activating the TRUNC signal. The shock delivered status is sent to the Main microcontroller which subsequently turns off the Patient relay and activates the Abort relay.

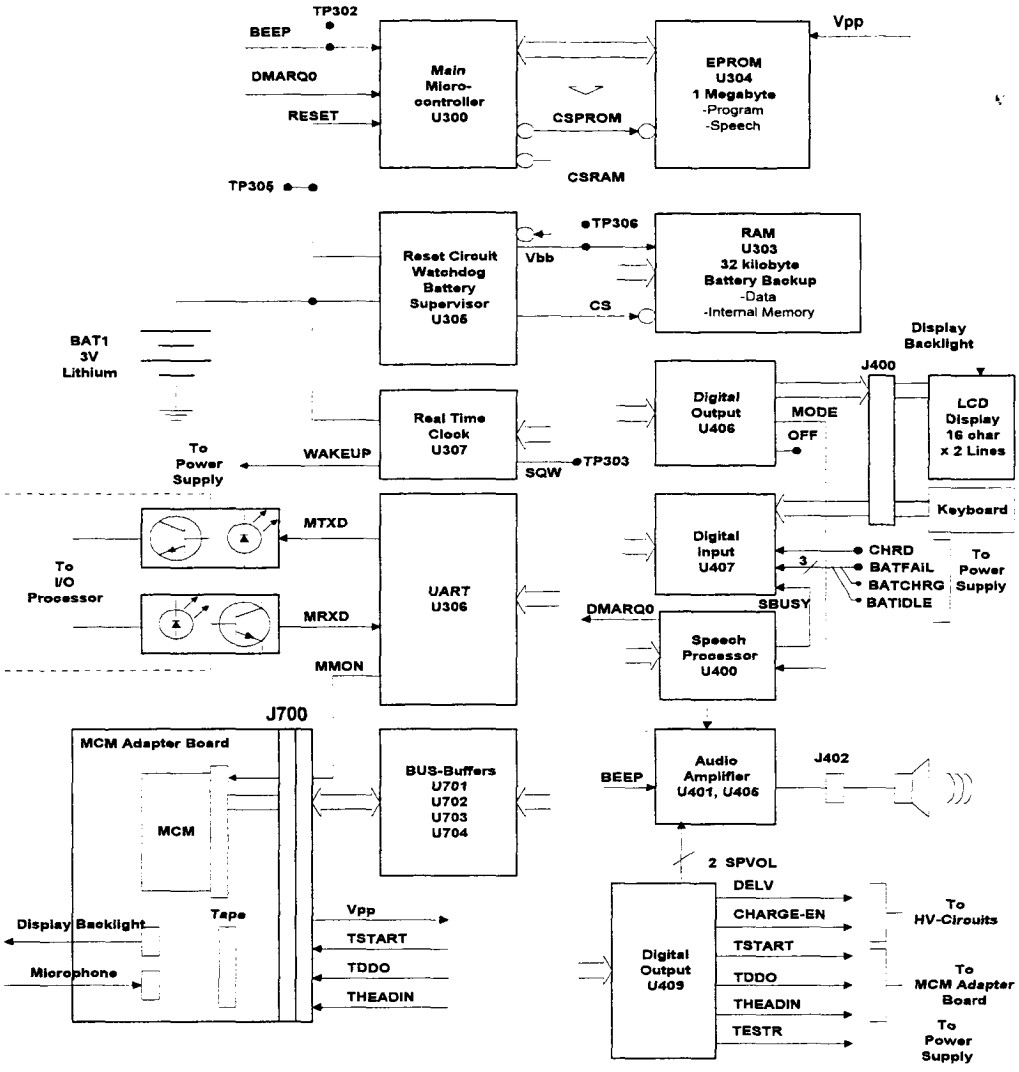


Fig. 3.5 - Main Microcontroller Functions

3.5 Main Microcontroller Functions

See figure 3.5 and FPS1328 electrical schematic pages 7,8 and 9.

EPROM U304 is a Flash EPROM, containing program and speech. The EPROM is in-unit re-programmable through special programming MCMs. Programming voltage Vpp must be supplied from the programming MCM.
RAM U303 is a static battery backup RAM, containing data, parameters and Internal Memory. Battery backup is controlled by U305.

Reset circuit U305 is a combined reset circuit, battery backup controller and watchdog circuit.

The real time clock / calendar, U307 is operated from the same lithium battery as the RAM. In addition to the clock / calendar, the chip also has a programmable WAKEUP signal, which can turn the unit on.

UART U306 is used to communicate with I/O-microcontroller. Data are sent in packages with checksum every 10 ms in each direction. The I/O-microcontroller sends ECG, electrode detection, surveillance and status data. The main microcontroller sends commands. The communication link is also used to download calibration table and other parameters to the I/O-microcontroller, using the "Calibration MCM". The whole calibration table is downloaded from the I/O-microcontroller to the main microcontroller at start up. The MMON line from the UART controls power on/off to the MCM.

Digital I/O, U406, U407 and U409 are used to control keyboard, display, tape, speech processor, high voltage circuits etc. The LCD display has self-contained controllers and memory.

The speech processor U400 operates on DMA. A speech sequence is started by setting up the internal DMA controller and activating the MODE line to the speech processor. The speech processor will then issue DMA-requests, (DMAREQ0) and speech data will be transferred to the speech processor when requested. SBUSY indicates that the speech processor is busy.
Speech and beeper audio is mixed, and amplified in the audio amplifier. Speech volume is controlled by the SPVOL lines.

Bus buffers U701- U704 are microprocessor data-, control- and address-bus buffers for the MCM memory.

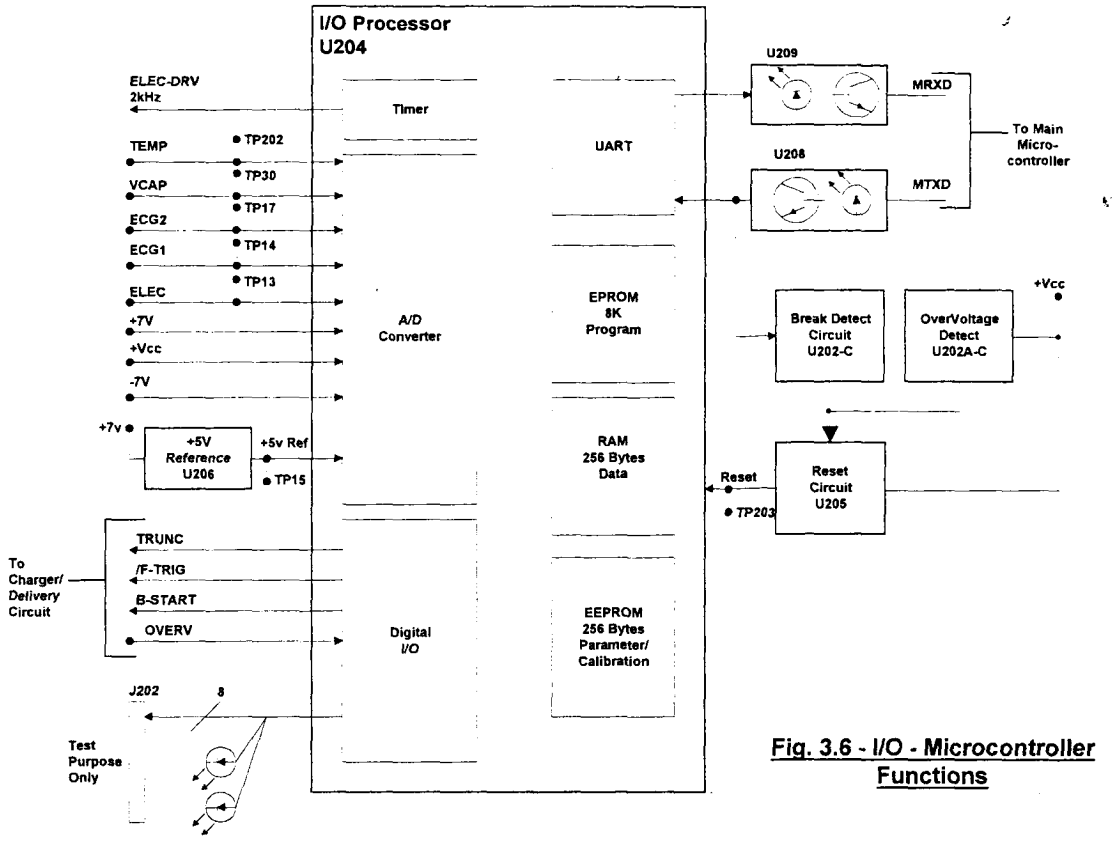


Fig. 3.6 - I/O - Microcontroller Functions

3.6 I/O-Microcontroller Functions

See figure 3.6 and FPS1328 electrical schematic page 6.
The I/O-microcontroller has built in EPROM for program memory, EEPROM, RAM, timer, serial communication, digital I/O and an 8 channel A/D converter.
The I/O-microcontroller communicates with the main microcontroller through serial communication, and the I/O-microcontroller operates strictly from commands given from the main microcontroller.

The EEPROM is used to store operational parameters and calibration data. The EEPROM is continuously checked for validity using a CRC check, and its data is replaced with default data from the EPROM if the EEPROM data are corrupted.

The A/D converter is used for acquisition of ECG, electrode connection data, temperature, capacitor voltage, and supply voltages. The A/D converter has a separate +5V reference generated by U206.

The I/O-microcontroller generates the 2 kHz ELEC-DRV signal, used by the electrode detection system. For detection of the Testload, the frequency of this signal is reduced to 45 Hz.

The charger and shock delivery circuits are controlled by the digital I/O lines TRUNC, B-START and /F-TRIG.

The I/O-microcontroller has a separate reset circuit which will activate if the supply voltage is too low or too high. The main microcontroller can also reset the I/O-microcontroller by sending "break' (holding the serial receive line low for a certain amount of time).

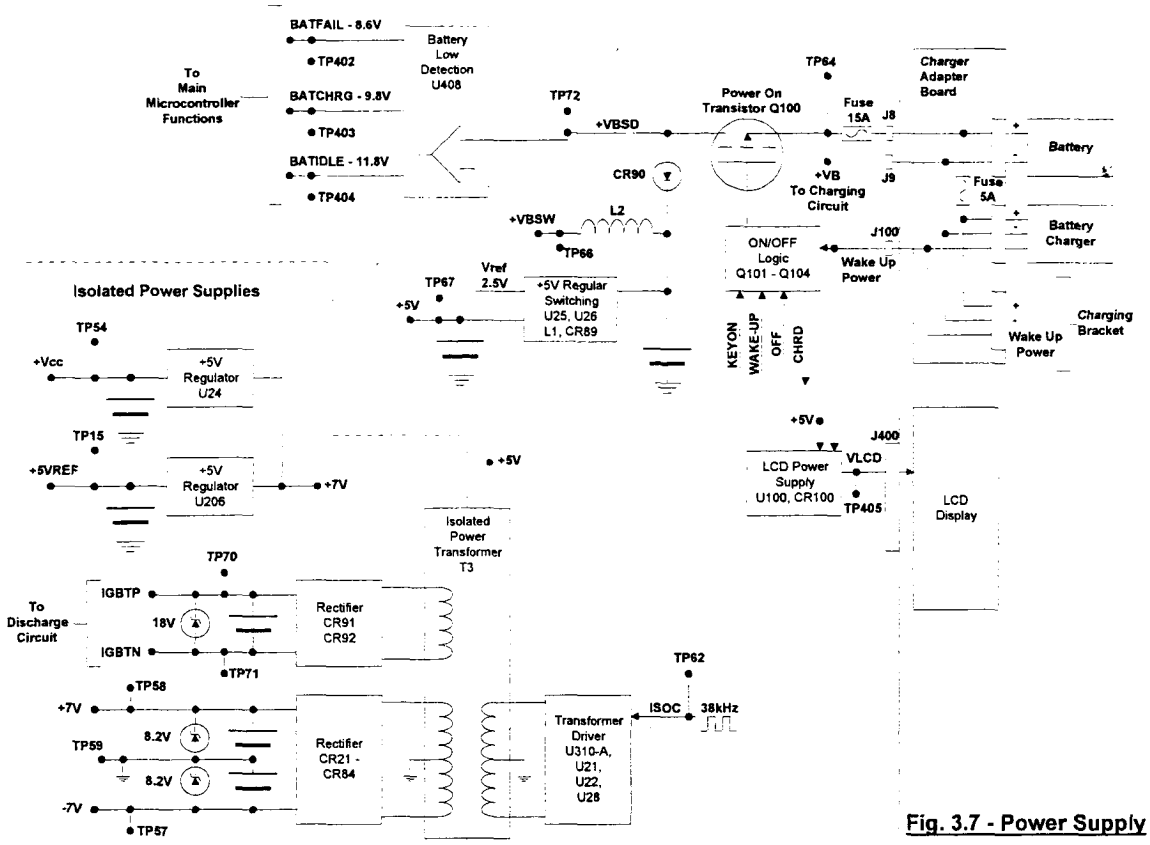


Fig. 3.7 - Power Supply

3.7 Power Supply

See figure 3.7 and FPS1328 electrical schematic page 5.

The unit is powered by a 12 V lead Acid battery. There are two battery charger connectors, one for direct connection to the battery charger, and one for connection via the charging bracket. The charger connectors are protected by a 5 A fuse, to prevent short circuit on the battery charger contacts to prevent the unit from operation. The charging circuit it powered directly from the battery voltage. This input is protected with a 15 A fuse. The remainder of the unit gets powered through the Q100 power-on transistor. CR90 prevents current surges from the HV-charger to affect the unit supply voltage.

The logic voltage for the non-isolated side is generated in the switching +5V regulator U25. This regulator also generates a +2.5V reference voltage used to determine battery low conditions by the comparators U408. The LCD display has a separate +5V regulator, since the LCD can also be powered from the Wake-Up power.

The unit can be turned on in three different ways; the power on-button, or connecting the unit to a charger with a Wake-Up power input, or via the WAKE-UP line from the Real time clock. Wake-Up power has to be present for the real time clock WAKE-UP to function.

Power to the isolated side is derived from the +5V through the isolated power transformer T3.

+7V and - 7V is used for the analog circuitry. +Vcc is logic +5V for the I/O-microcontroller, while +5VREF is the reference voltage for the I/O-microcontroller A/D-converter.

IGBTP and IGBTN voltage is used to drive the IGBT. This voltage is floating on the unit's high voltage, and is isolated from the other voltages.

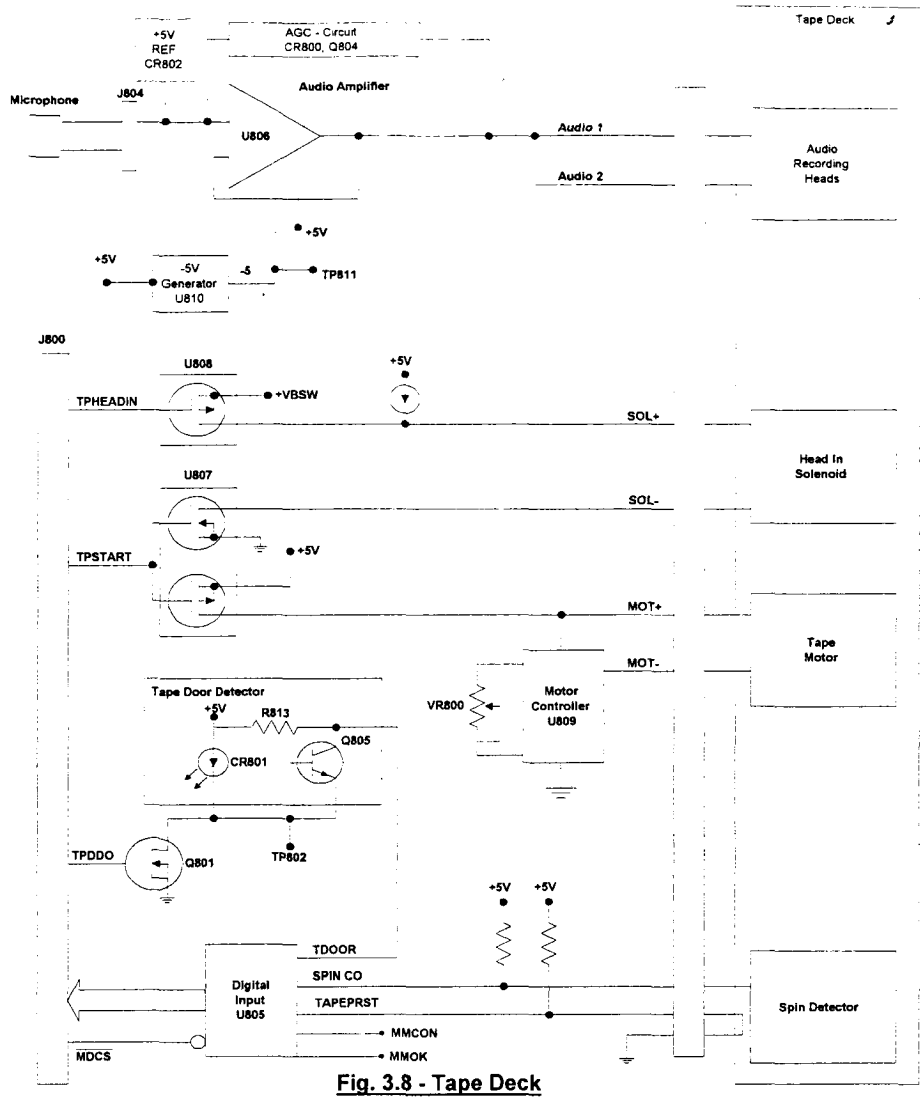


Fig. 3.8 - Tape Deck

3.8 Tape Deck

See figure 3.8 and FPS1332 electrical schematic.

The tape deck circuitry resides on the MCM adapter board, FPS1332. Units without tape may not have the tape circuitry mounted.

Audio is picked up by the microphone and amplified in U806. U806 has an automatic gain circuit. Bias voltage for the microphone is generated by voltage reference CR802. The audio amplifier U806 needs a -5V negative supply voltage which is generated by U810.

Tape start and stop is controlled by the main microcontroller via the signals TPSTRT and TPHEADIN. TPSTART starts the motor and enables the tape head solenoid hold voltage. TPHEADIN enables the tape head solenoid pull in voltage. The motor speed is controlled by U809 and is adjustable by potentiometer VR800.

The tape door position is detected by the optical sensor Q805 and the infrared emitter CR801. CR801 is turned on with regular intervals by the main microcontroller and the door detector is read. The tape door has a notch blocking the opening between CR801 and Q805 when in the closed position.

The tape deck has an optical spin detector which output is read by the main microcontroller, and used to detect if a tape is present, or if the end of tape is reached.

The TAPEPRSNT signal is used to detect whether a tape deck is present or not. The MMCON and MMOK signals are used to detect if an MCM is present.

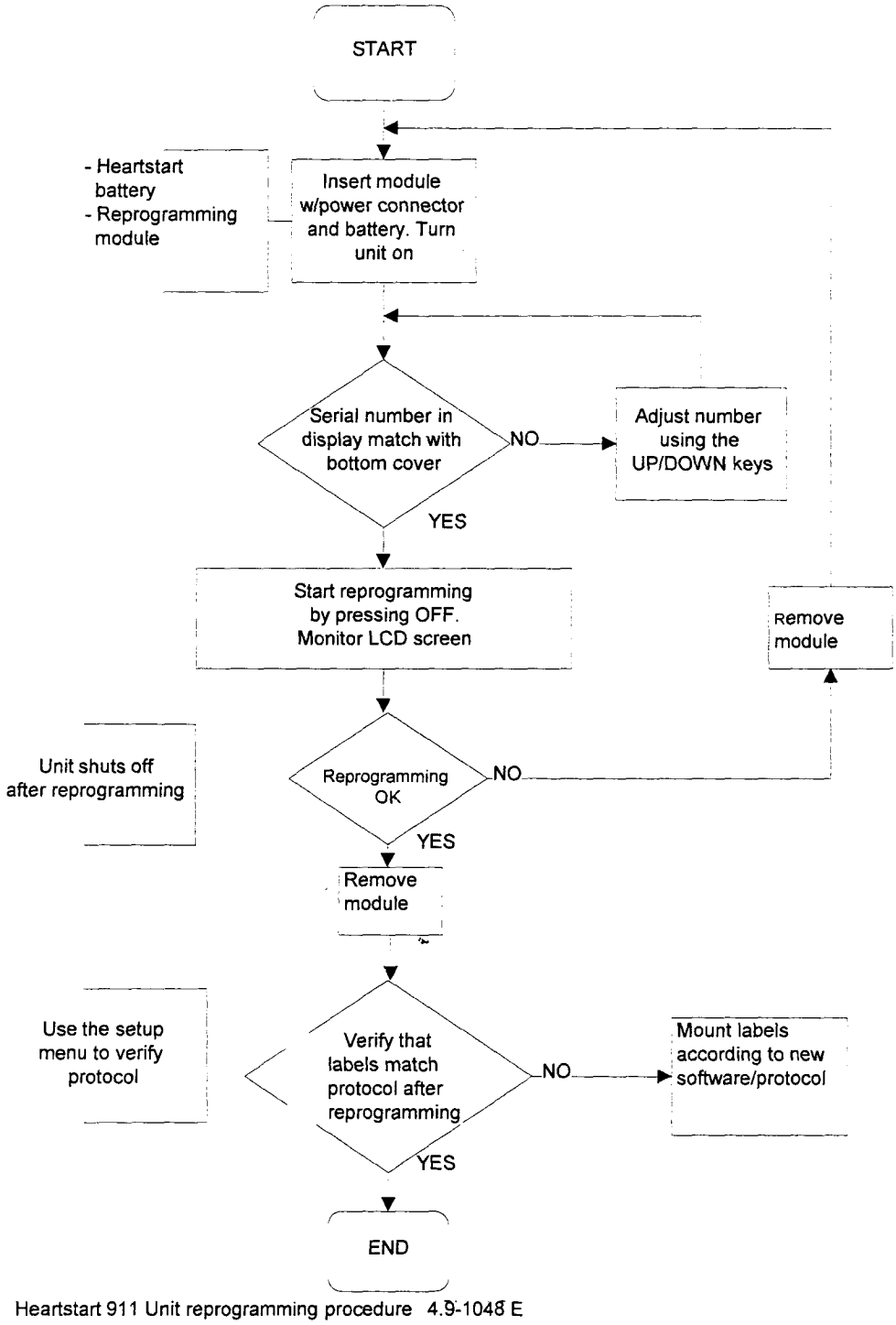
4.0 Service and Maintenance

4.1 Unit Reprogramming

4.1.1 Equipment

Power supply with dummy battery(at least 10 Amp.12VDC) or newly charged HS battery (Catalog no.901100)
Heartstart 911 programming module

4.1.2 Reprogramming Procedure



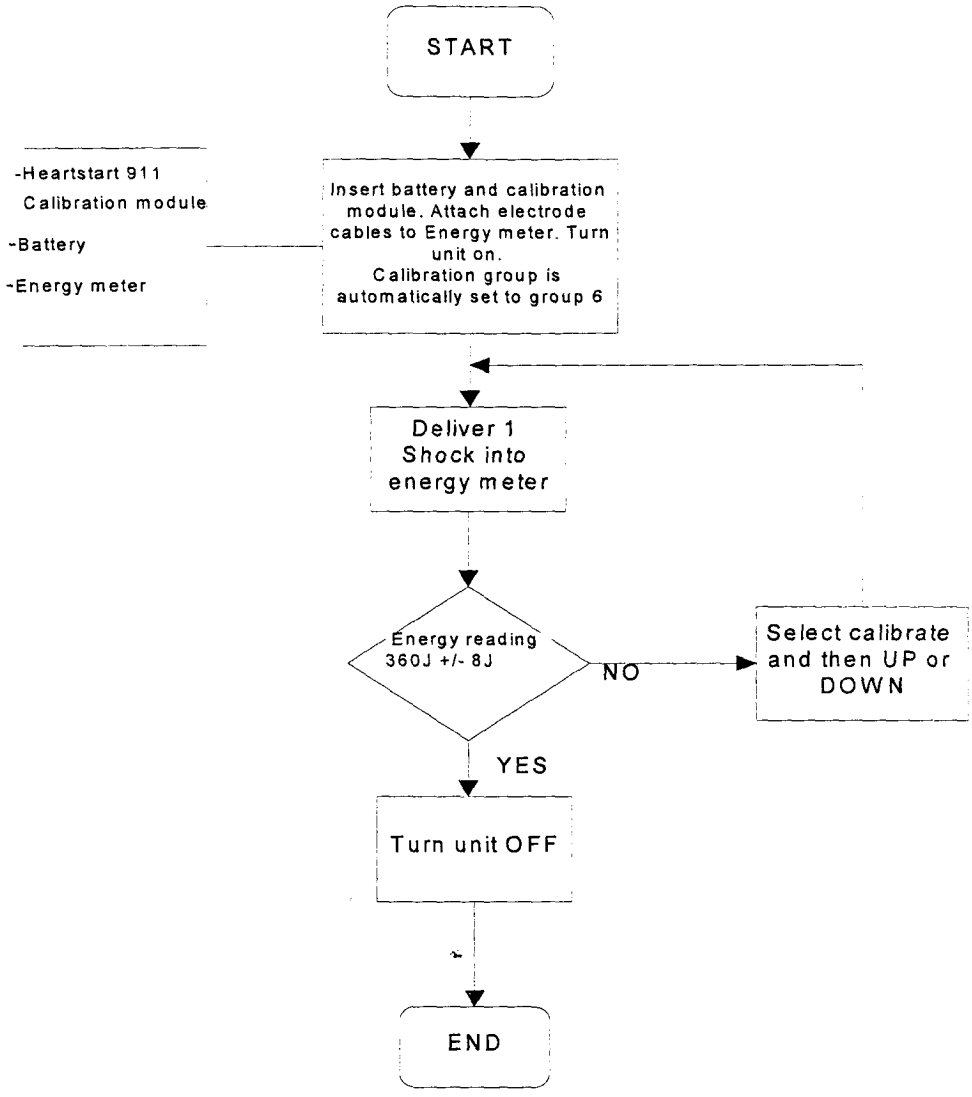
Heartstart 911 Unit reprogramming procedure 4.9-1048 E

4.2 Calibration

4.2.1 Equipment

Power supply with dummy battery(at least 10 Amp.12VDC) or newly charged HS battery (Catalog no.901100)
Heartstart 911 Calibration module MHF060101
Energy meter with rhythm simulator (Biotek QED-6 or equivalent)

4.2.2 Calibration Procedure


START
-Heartstart 911 Calibration module
-Battery
-Energy meter
Insert battery and calibration module. Attach electrode cables to Energy meter. Turn unit on. Calibration group is automatically set to group 6
Deliver 1 Shock into energy meter
Energy reading 360J +/- 8J
NO
Select calibrate and then UP or DOWN
YES
Turn unit OFF
END

Heartstart 911 Calibration Procedure 4.9-1047-E

4.3 After Service Test

4.3.1 Test Equipment

Power supply with dummy battery or newly charged battery.
MCM Plus module
Energy meter with rhythm simulator.
Heartstart 911 charging bracket with charger
Micro Cassette
Tape player, (Dictaphone)

4.3.2 Test Procedure

Function	Check / Perform	OK √
Visual check	Cables.	
	Labels	
	Screws	
	Softpack	
	Tape door	
Shake test	Shake unit, listen for loose parts.	
Enter SETUP	Display is OK	
	Display backlight is ON	
Setup, VOLUME	LOW, OK	
	MEDIUM, OK	
	HIGH, OK	
	Set Volume to MEDIUM	
Setup, VERSIONS Register / Check	Main SW- version	
	I/O SW-version	
	Protocol	
	Calibration group #	
	Shock count	
Setup, AUTO-TEST	Set ENABLED	
	Set 12:00	
Install MCM. Install Tape if applicable. Setup, MCM CLEAR	Clear MCM	
Attach electrodes to Testload. Turn unit ON	"ATTACH ELECTRODES" displayed	
Attach electrodes to Energy Meter v/VF Deliver 3 shocks.	Verify Energy & protocol. 1. SHOCK: 200 J+/- 15%	
	2. SHOCK: 200/300 J +/-15%	
	3. SHOCK: 360 J +/-15%	
	Speech and Beep OK.	
Energy meter to NSR	NO SHOCK INDIC	
Print MCM.	MCM report OK. Check time, date and S/N	
Replay tape.	Tape recording OK	
Setup, CLOCK	Set clock to 11:59	
Attach electrodes to Testload. Install unit in charging bracket.	AUTO SELFTEST OK 11:59	
Wait for one minute.	Unit turns on automatically. AUTO SELFTEST OK 12:00	
Battery Charger	FAST or TRICKLE lights on charger	
Turn unit On while connected to Charger.	Warning 52	
Connect battery charger directly to unit.	AUTO SELFTEST OK	
Setup, CLOCK	Set clock to correct time.	

5.0 Mechanical Construction

The mechanical construction of the Heartstart 911 is shown in figures Top Assy. This chapter will describe in detail how the unit is disassembled and reassembled.

For disassembly and reassembly, a medium power screwdriver is needed. The torque specifications is set to 1,3 Nm.

5.1 Disassembly

5.1.1 Case Bottom

The case bottom is removed by unscrewing 8 screws in the bottom. The screw at the lower right side is hidden under a white label. This label cannot be removed but must be penetrated with the screwdriver. When all the screws are removed, the case bottom can be lifted off.

5.1.2 Main Board

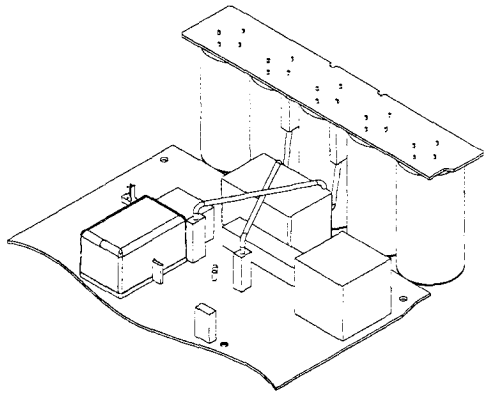
Unscrew the one screw that holds the main board in place. Pull out the flat wire for the display and keyboard. Lift the main board carefully to get access to the other connectors and unplug them carefully. When this is done the main board can be lifted out together with the adapter board.

5.2 Assembly

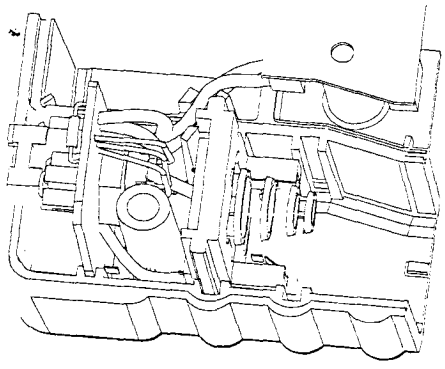
Before refitting the bottom, the following has to be checked:

5.2.1
Check that the black cover is in place on the blitz tube and that no damage has occurred to the "trigger" wire.

5.2.2
Check that the 2 wires from the capacitor board is connected to the main board (J1, J2) and that the wires form a cross underneath the main board when the capacitor board is situated correct. See figure.



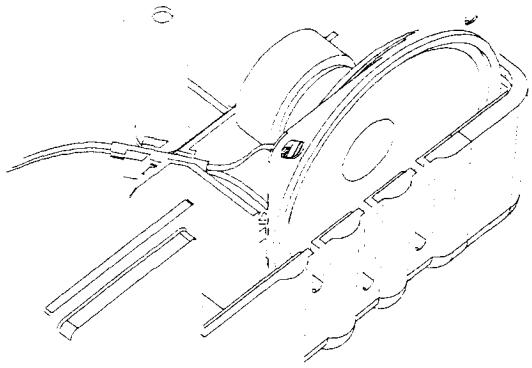
5.2.3
Be observant on the 3 wires from the battery/charger connector. The wires are to be placed in the appropriate slot and connected to the main board (J8, J9, J100). See figure.



5.2.4
Check that the cable for the keyboard is in place and locked in the connector on the main board (J400).

5.2.5
The "backlight" cable is to be connected to the 2 pin connector on the MCM adapter board.

5.2.6
Check that the speaker is in its correct position and is held in place with two rubber feet. The cable is connected to the 2 pin (J401) on the main board. Ensure that the 2 wires do not touch the test load mounted in the case top. The wires are to be placed in the slot of the cabinet where the shrink tube protection is on the wire .See figure.



5.2.7
The main board is mounted with one screw.

5.2.8
Check that the silicone gasket is in place in the slot of the cabinet. Be aware of the area around the MCM adapter board.

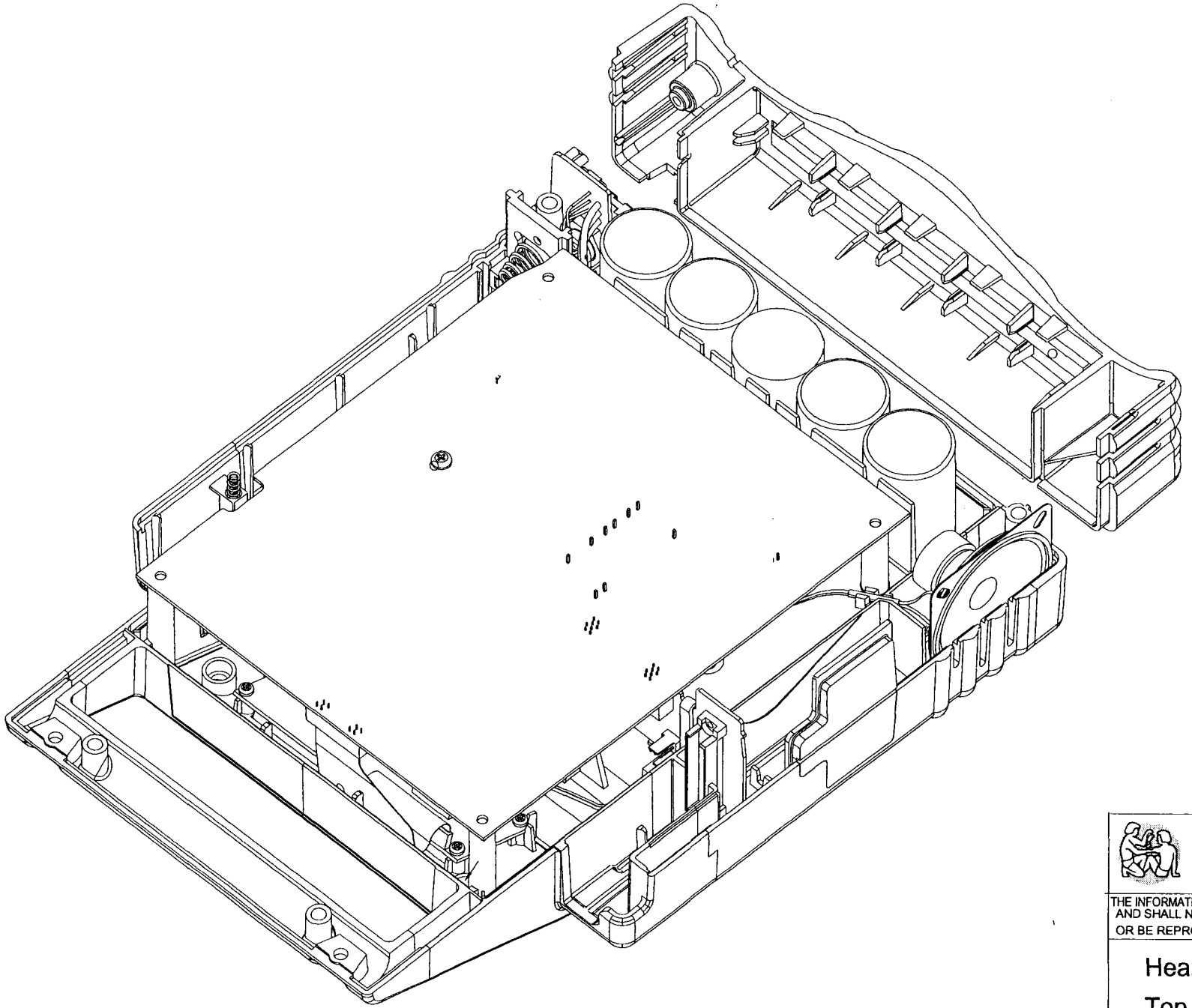
5.2.9
Units with a tape deck
- Check that the cable from the tape to MCM adapter board has been locked.
- Check the movement of the tape door.
- Check that the microphone has been connected to the 2 pin connector(J) on the MCM adapter board.

5.2.10
Units without a tape deck
Check that the lid door has been properly mounted.

5.2.11
Check that the battery ejector with spring is in place.

5.2.12
Put on the back cover and assure that it is firmly in place. If it does not fit in properly the first time, the back cover needs to be lifted and revert to the start of the assembly procedure.

5.2.13
Shake the unit to verify that no loose components are left in the unit. Assemble with the 8 screws at a torque of 1.3 Nm. Put on the white label on the screw at the lower right corner.



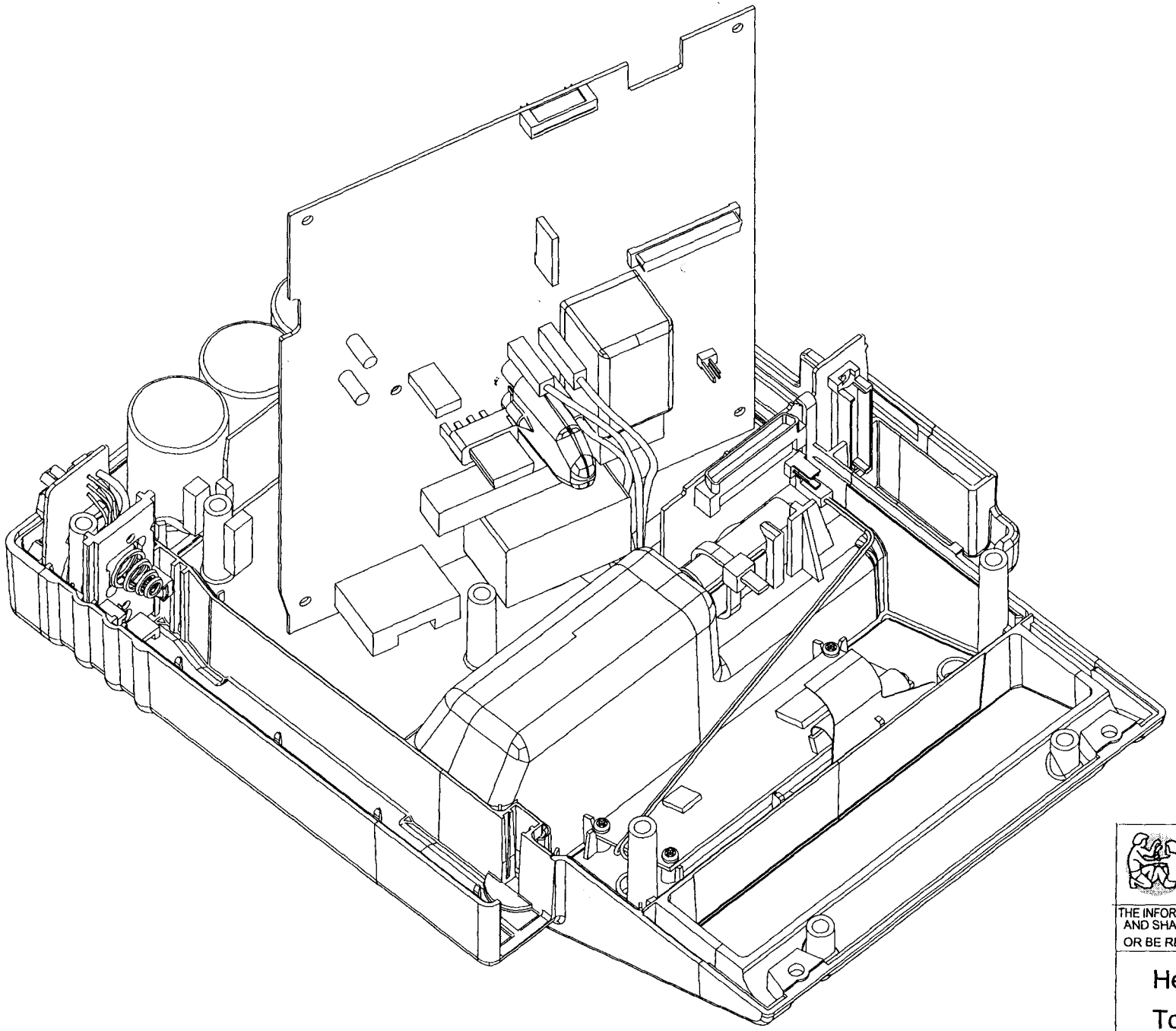
Laerdal

helping save lives

THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

Heartstart 911

Top Assy



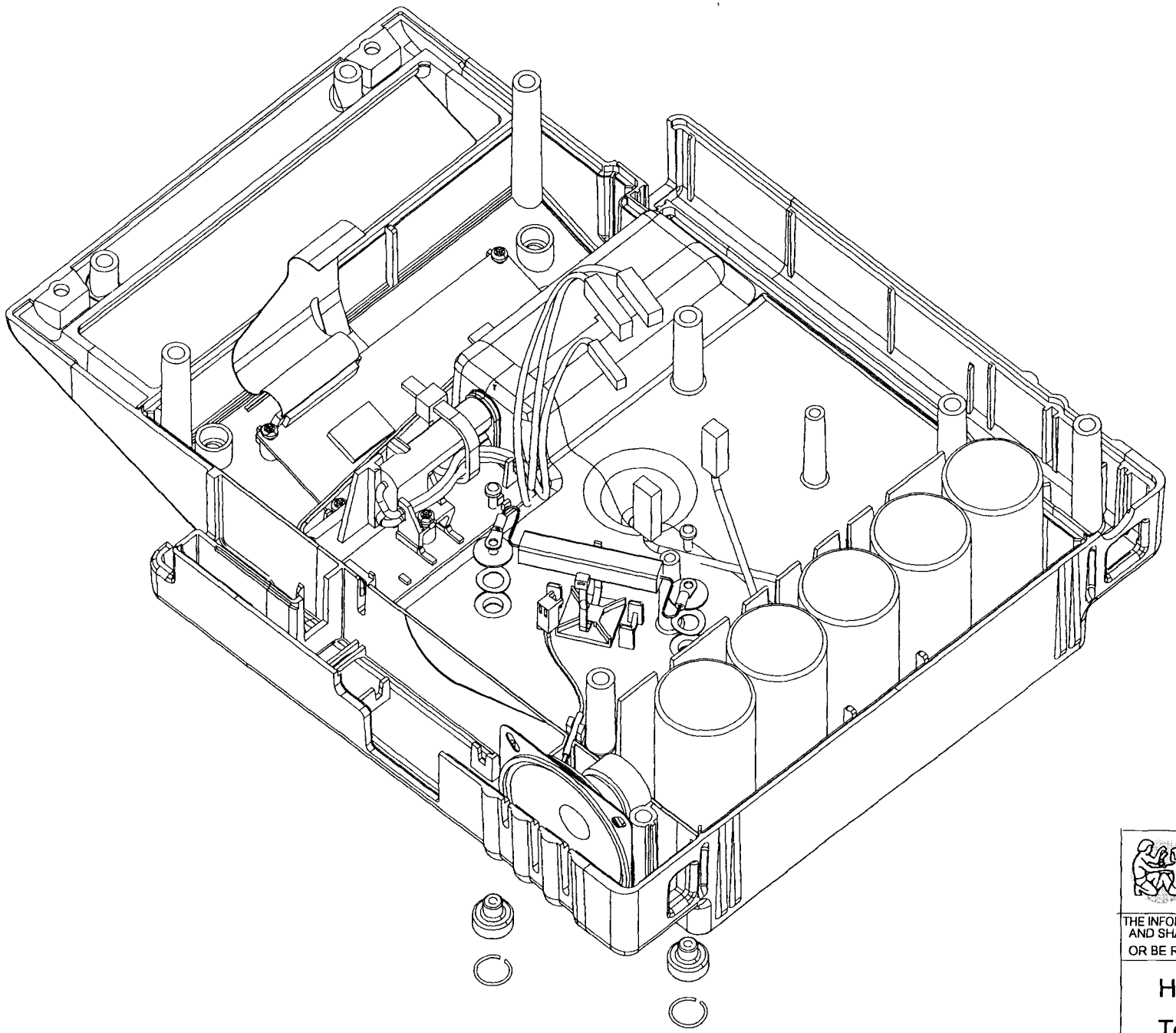
Laerdal

helping save lives

THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

Heartstart 911

Top Assy



Laerdal
helping save lives

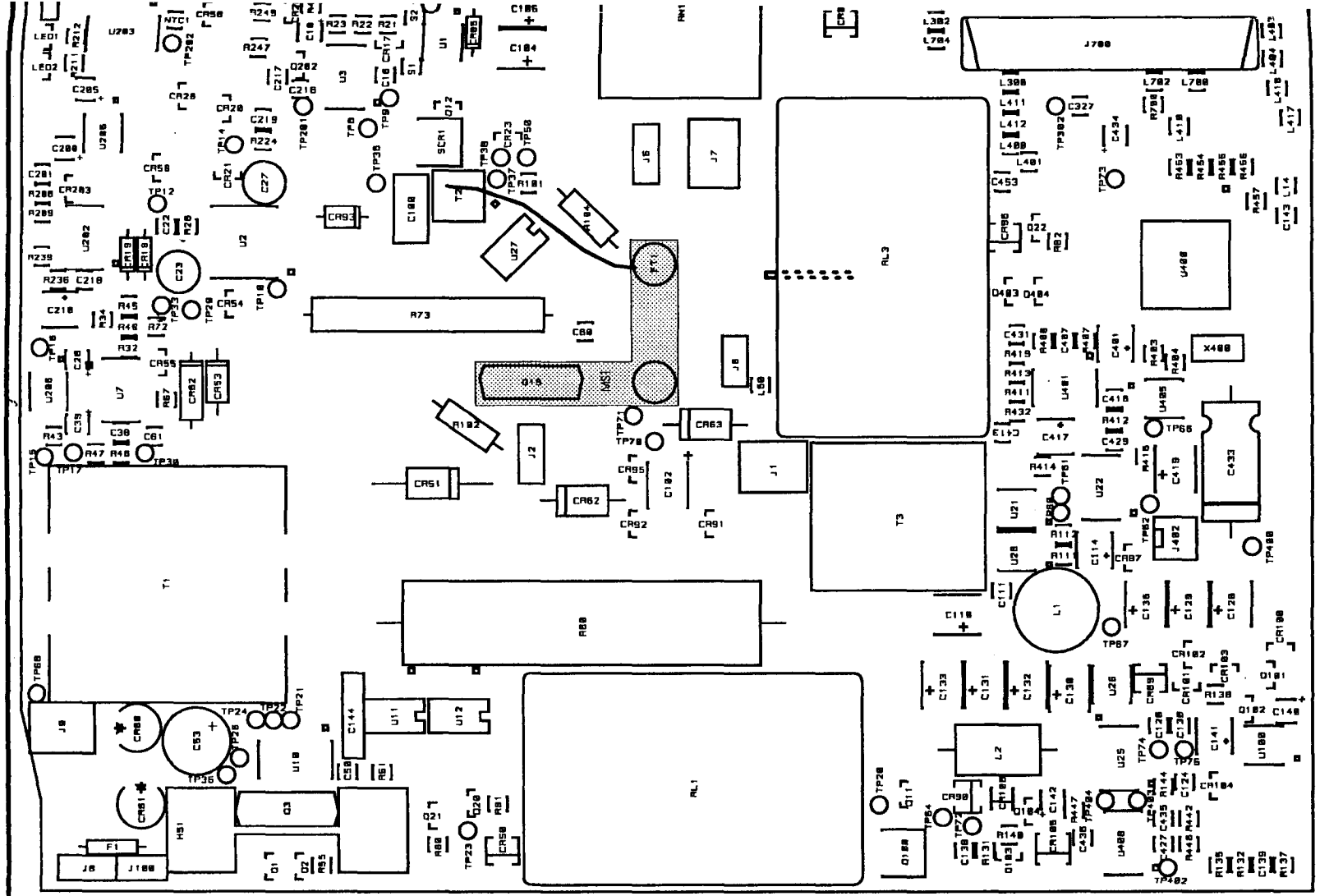
THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

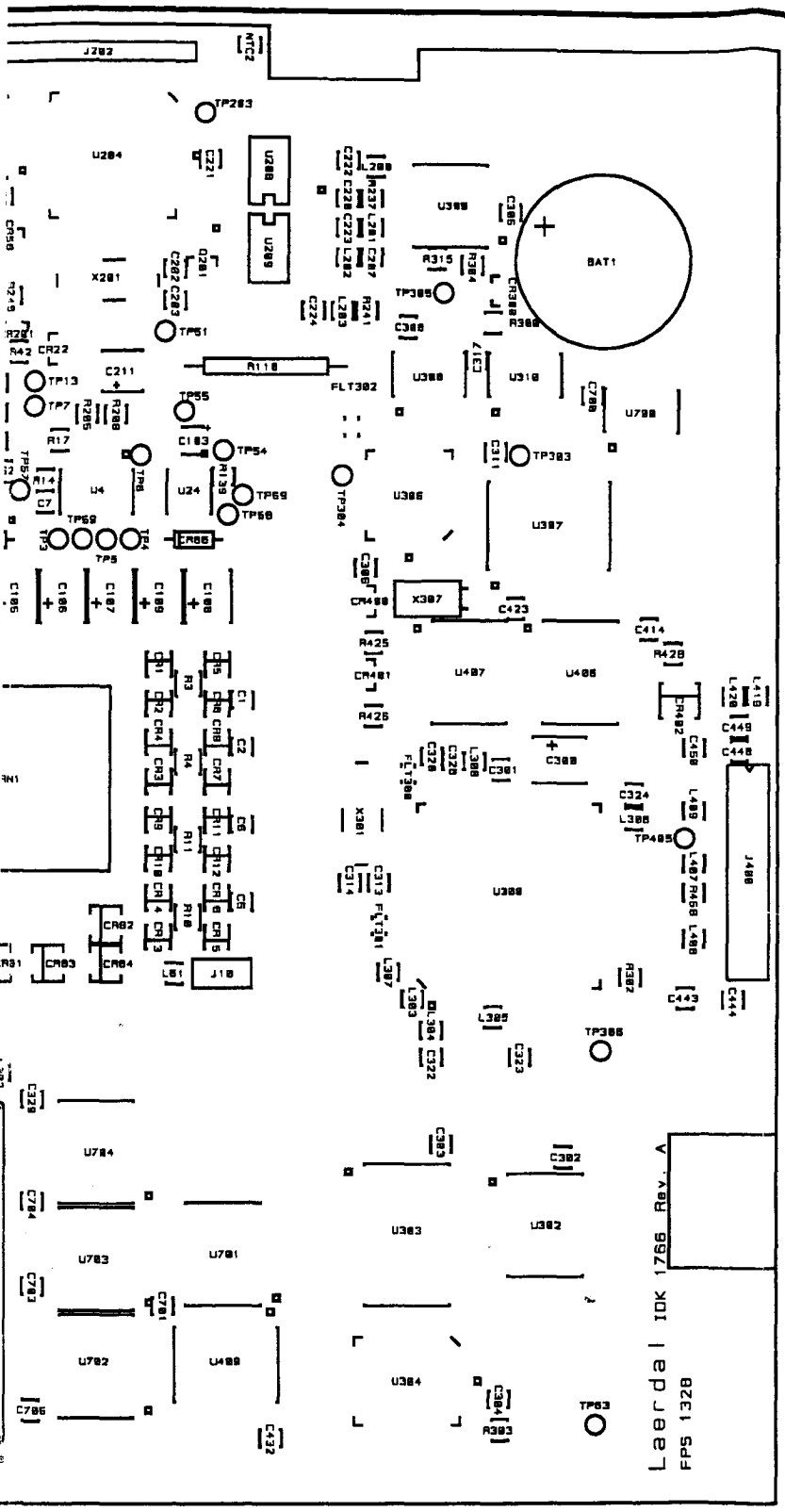
Heartstart 911

Top Assy

Heartstart 911 spare parts list

Catalog no.	Description
920620	Patient cable
925209	Clock battery
930100	Main Board
930110	MCM adapter board
930111	MCM adapterboard w/Tape deck electronics
930400	Tape deck
930120	Battery receptackle
930130	Speaker assy
930500	Keyboard
930510	Display
930140	Capasitor bank
930125	Patient cable receptacle
930200	Top hat (softpack)





Laerdal
helping save lives

POB 377
N-4001 STAVANGER
NORWAY

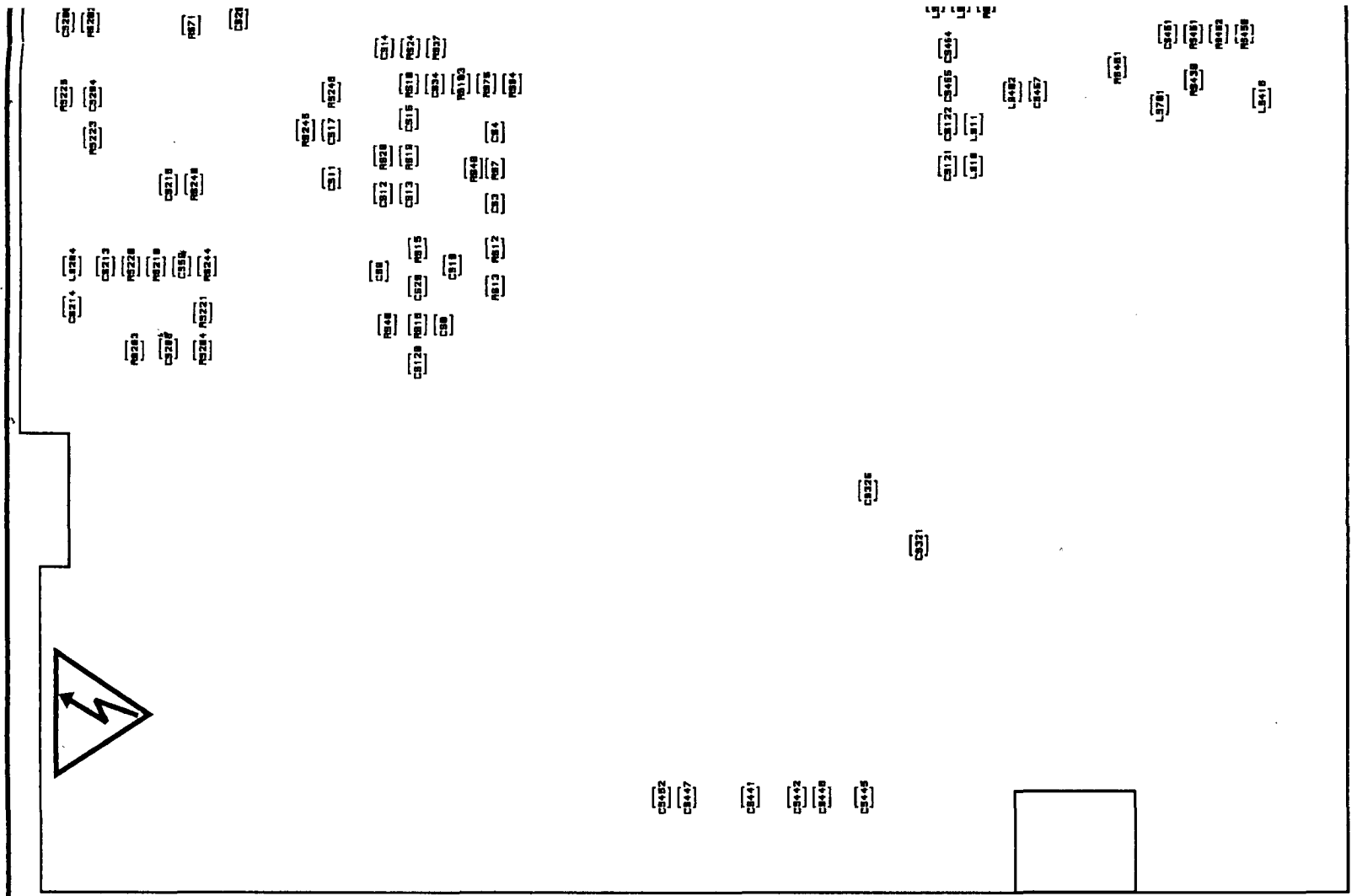
THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

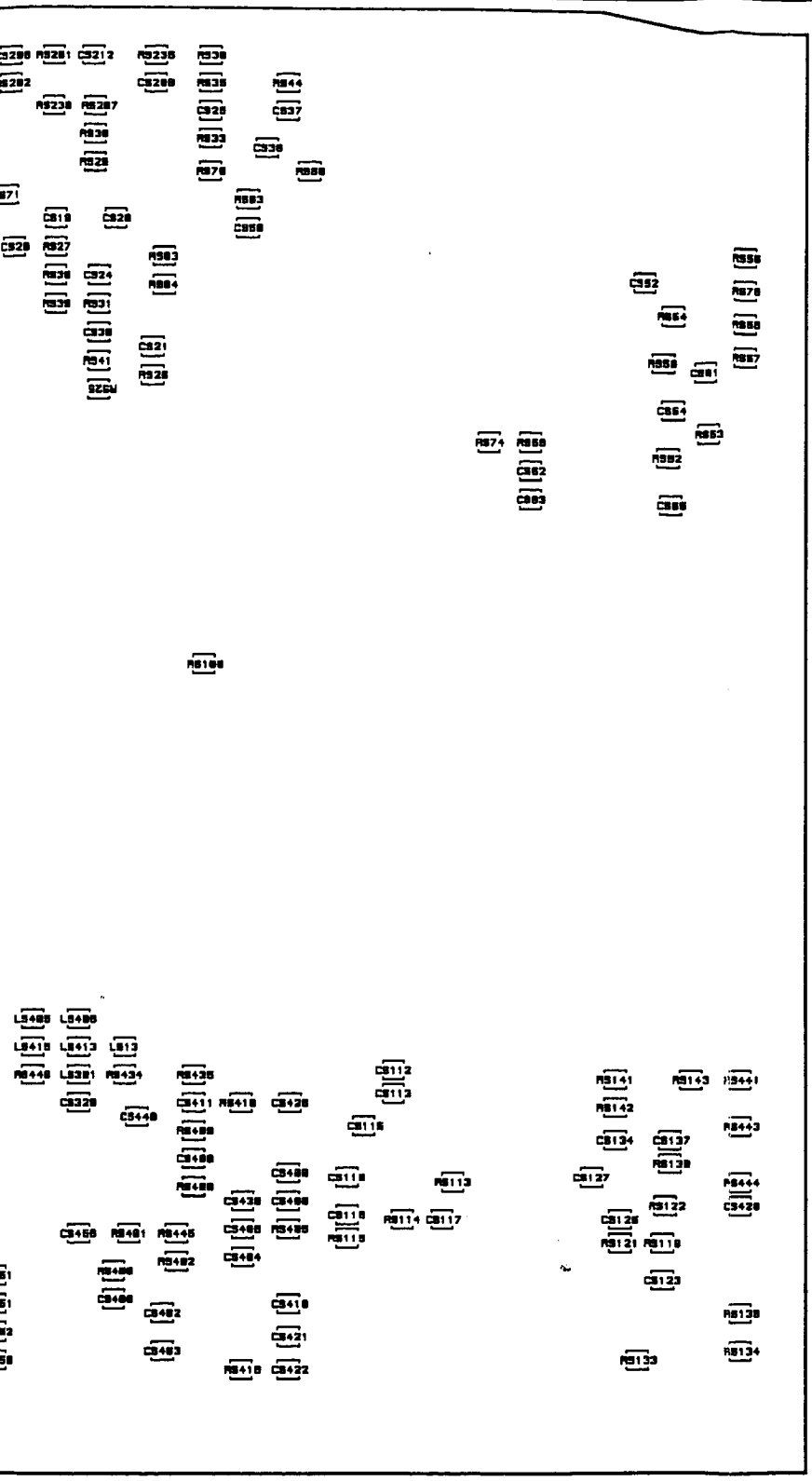
TITLE

HS911 Main Board
Assembly Drawing, component side

File: F13281BS.CDR

Rev. B





Laerdal
helping save lives

POB 377
N-4001 STAVANGER
NORWAY

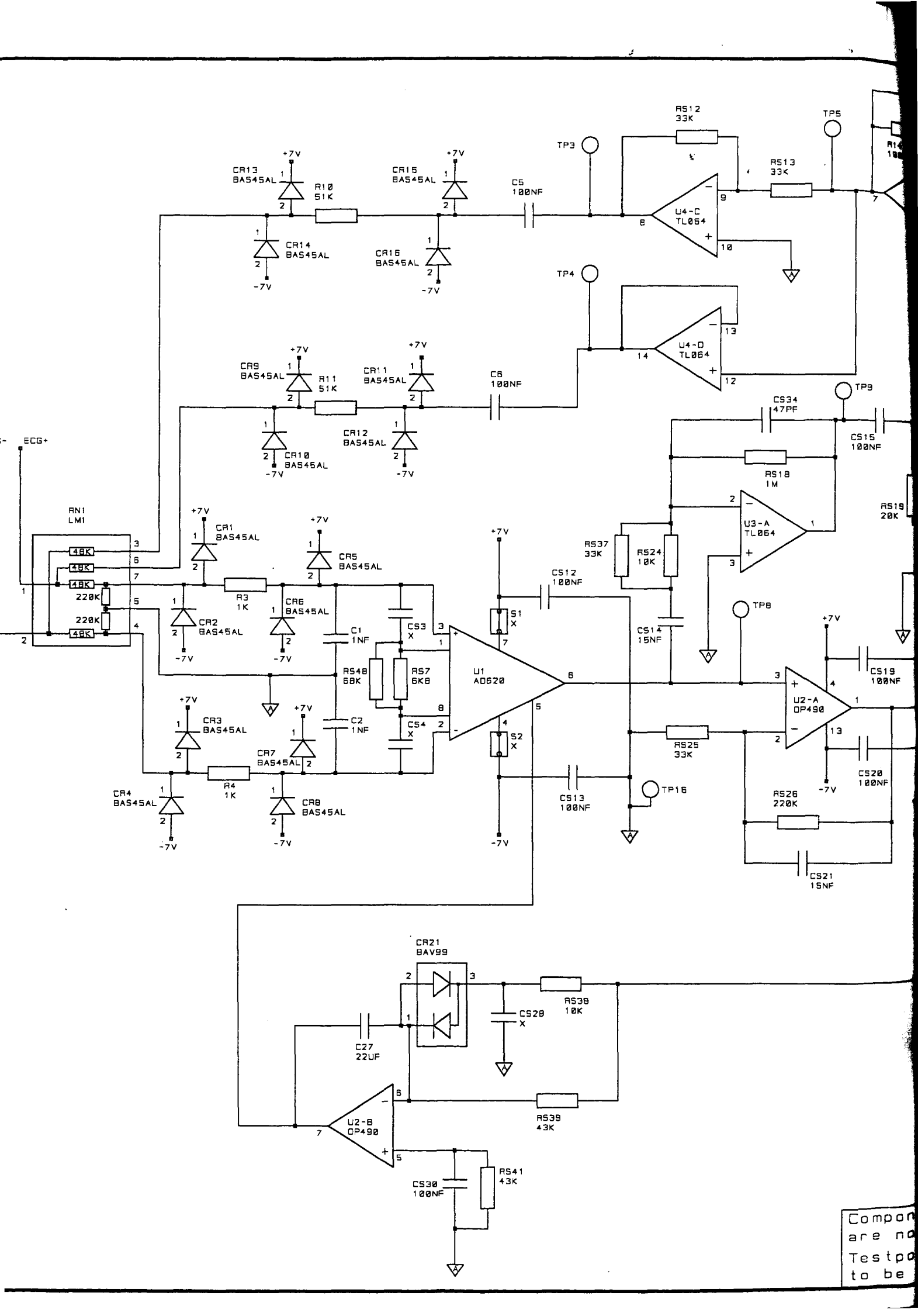
THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL
AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO
OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

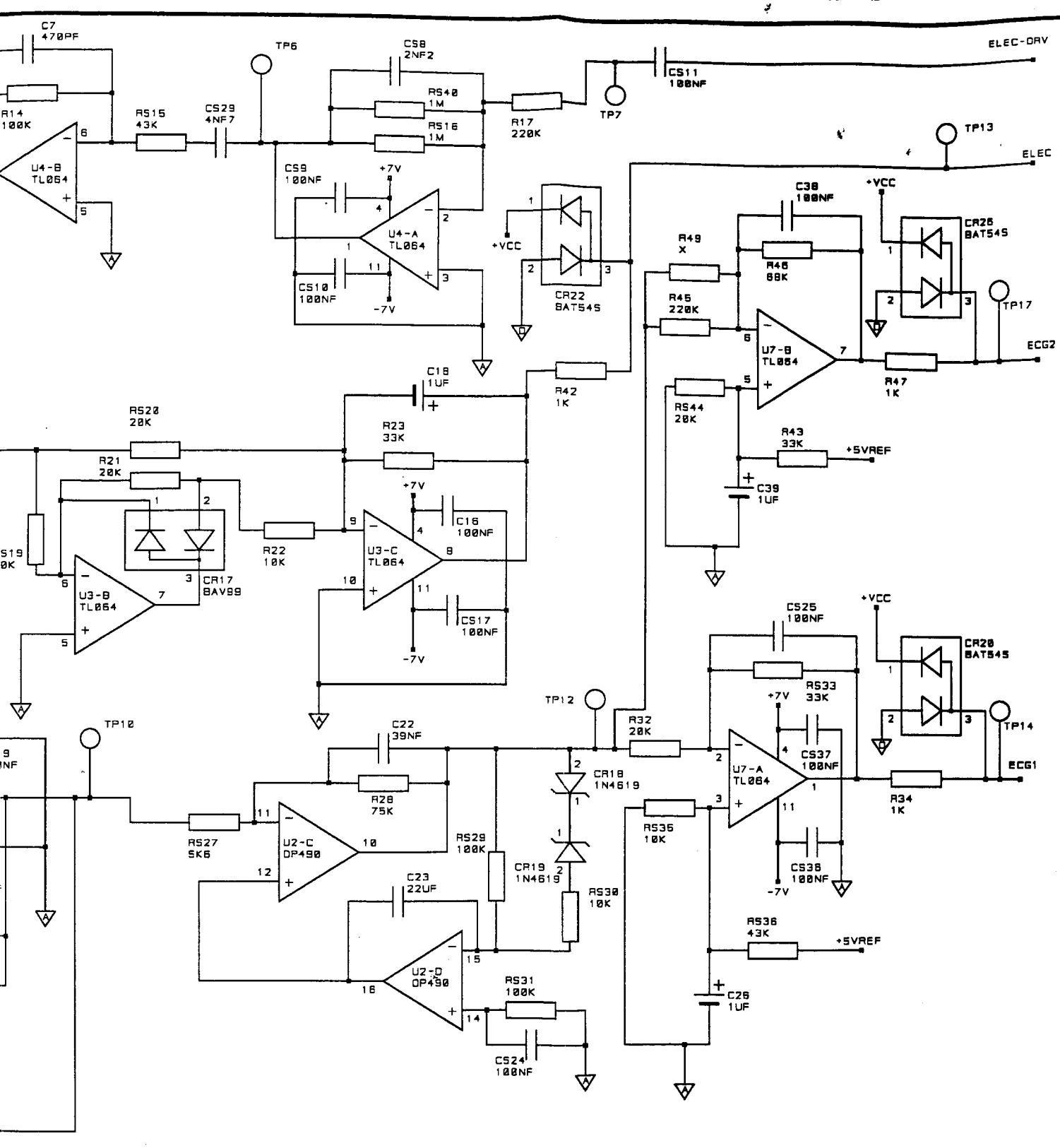
TITLE

HS911 Main Board
Assembly Drawing, solder side

File: F13282BS.CDR

Rev. B
Sheet: 2 of 9


CR13 BAS45AL
R10 51K
CR15 BAS45AL
C5 100NF
TP3
RS12 33K
TP5
RS13 33K
U4-C TL064
CR14 BAS45AL
CR16 BAS45AL
TP4
U4-D TL064
CR9 BAS45AL
R11 51K
CR11 BAS45AL
C6 100NF
CR10 BAS45AL
CR12 BAS45AL
TP9
CS34 47PF
CS15 100NF
RS18 1M
RS19 20K
U3-A TL064
RN1 LM1
ECG+
CR1 BAS45AL
CR5 BAS45AL
RS37 33K
RS24 10K
CS12 100NF
CR2 BAS45AL
R3 1K
CR6 BAS45AL
CS14 15NF
TP8
S1 X
CS3 X
C1 1NF
RS48 68K
RS7 6K8
U1 AD620
CS4 X
S2 X
C2 1NF
CR3 BAS45AL
CR7 BAS45AL
R4 1K
CR4 BAS45AL
CR8 BAS45AL
CS13 100NF
TP16
U2-A OP490
CS19 100NF
CS20 100NF
RS25 33K
RS26 220K
CS21 15NF
CR21 BAV99
RS38 10K
CS28 X
C27 22UF
U2-B OP490
RS39 43K
CS30 100NF
RS41 43K
+7V
-7V
Compon
are no
Testpo
to be



ponents with value X
not to be mounted
tpoints, TP, are not
be mounted

PCB1
ICK1756 REV.A

Laerdal
helping save lives

POB 377
N-4001 STAVANGER
NORWAY

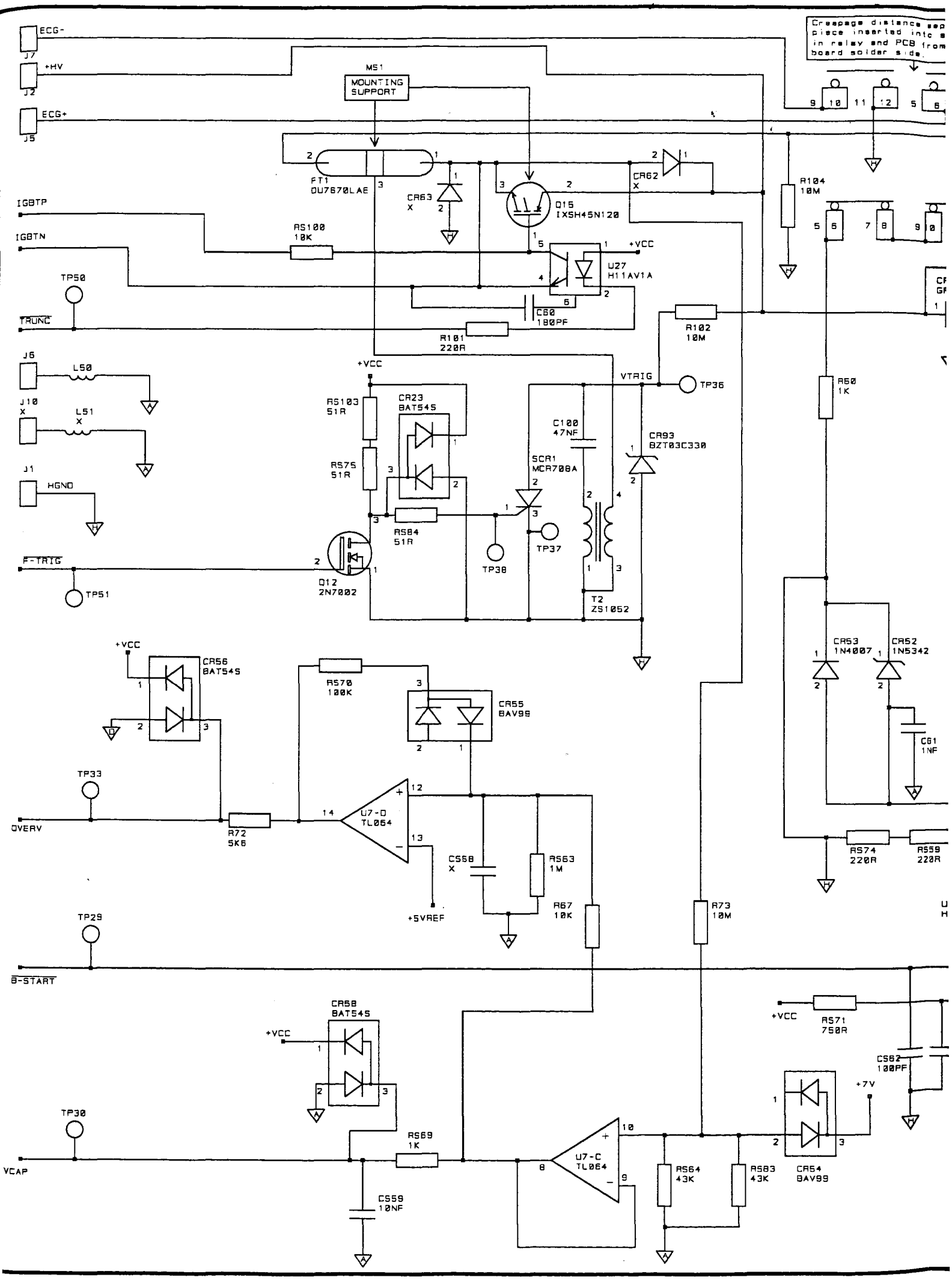
THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

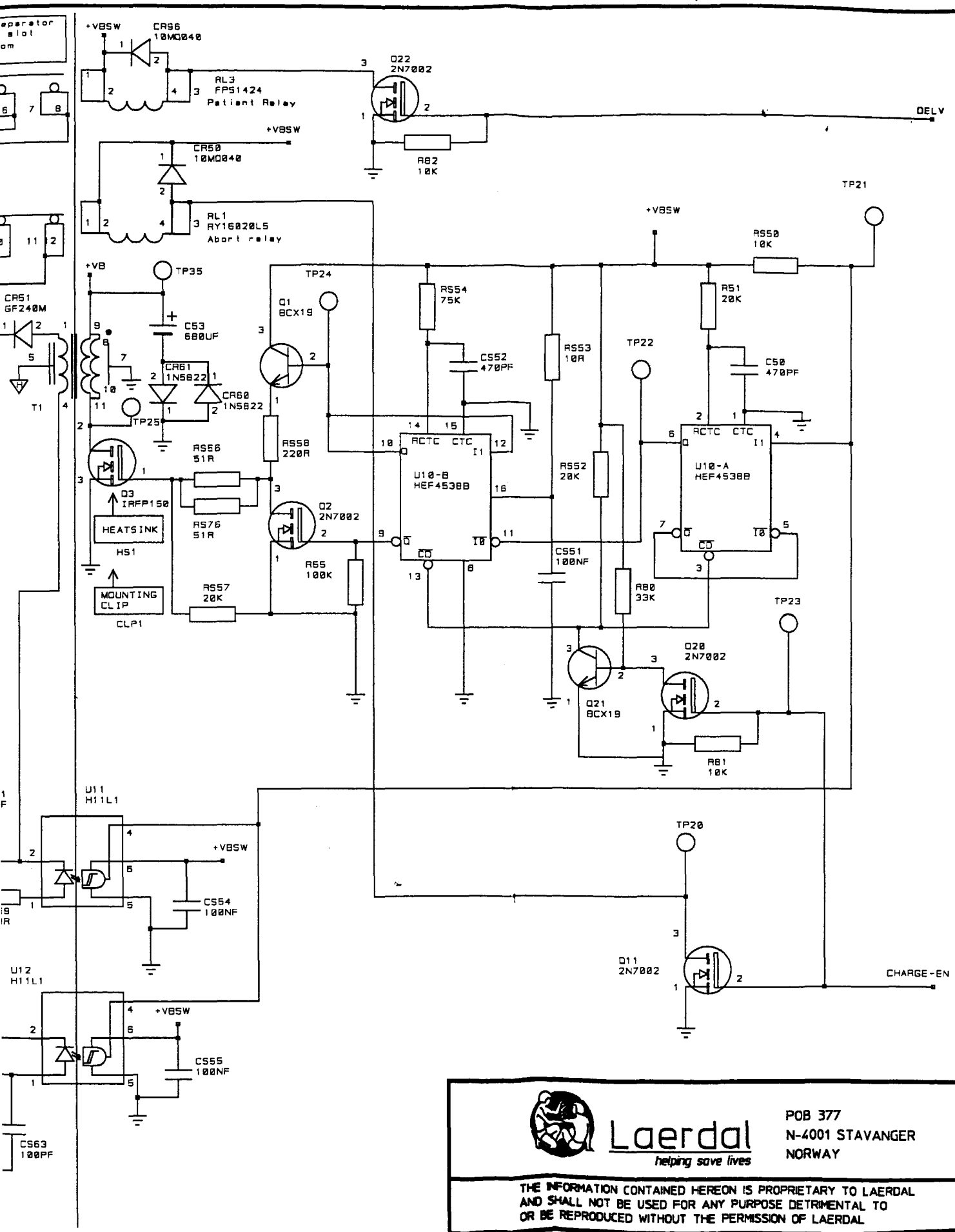
TITLE

HS911 Main Board
ECG/Electrode connection system

File: F13283BS.CDR

Rev. B
Sheet: 3 of 9


ECG-
J7
+HV
J2
ECG+
J5
MS1
MOUNTING SUPPORT
FT1
OU7670LAE
CR63
X
Q15
IXSH45N120
CR62
X
R104
10M
IGBTP
IGBTN
RS100
10K
+VCC
U27
H11AV1A
TP50
TRUNC
C60
180PF
R101
220R
R102
10M
J6
L50
J10
X
L51
X
J1
HGND
+VCC
VTRIG
TP36
R60
1K
RS103
51R
CR23
BAT545
RS75
51R
C100
47NF
CR93
BZT03C330
SCR1
MCR708A
RS84
51R
TP37
TP38
F-TRIG
TP51
Q12
2N7002
T2
ZS1052
CR53
1N4007
CR52
1N5342
C61
1NF
+VCC
CR56
BAT545
R570
100K
CR55
BAV99
TP33
OVERV
R72
5K6
U7-D
TL064
CS58
X
RS63
1M
R67
10K
+5VREF
RS74
220R
RS59
220R
R73
10M
TP29
B-START
CR58
BAT545
+VCC
RS71
750R
CS62
100PF
+7V
TP30
VCAP
RS69
1K
U7-C
TL064
CS59
10NF
RS64
43K
RS83
43K
CR54
BAV99



Isolation border

Components with value X are not to be mounted

Testpoints, TP, are not to be mounted

Laerdal
helping save lives

POB 377
N-4001 STAVANGER
NORWAY

THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

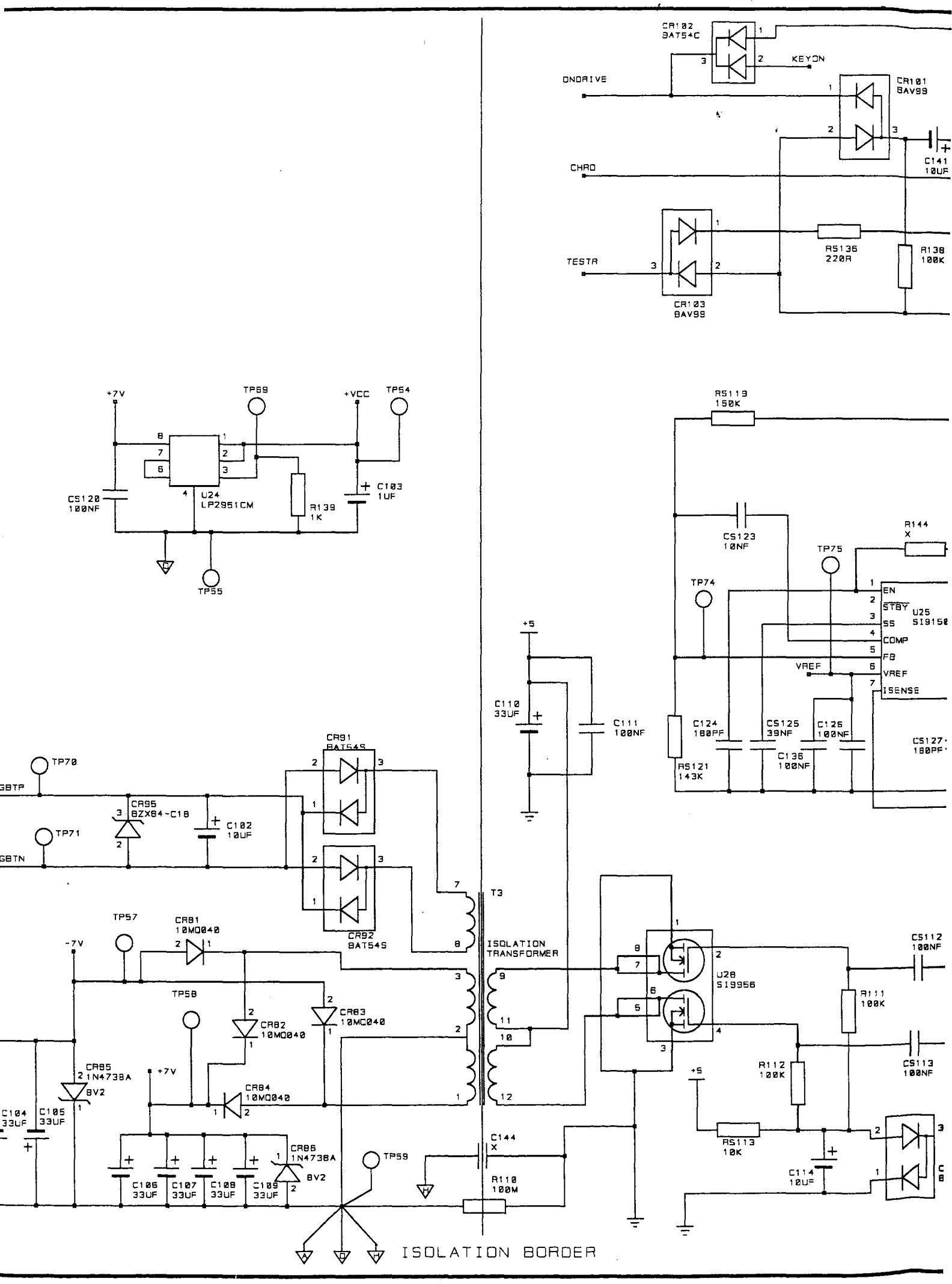
TITLE

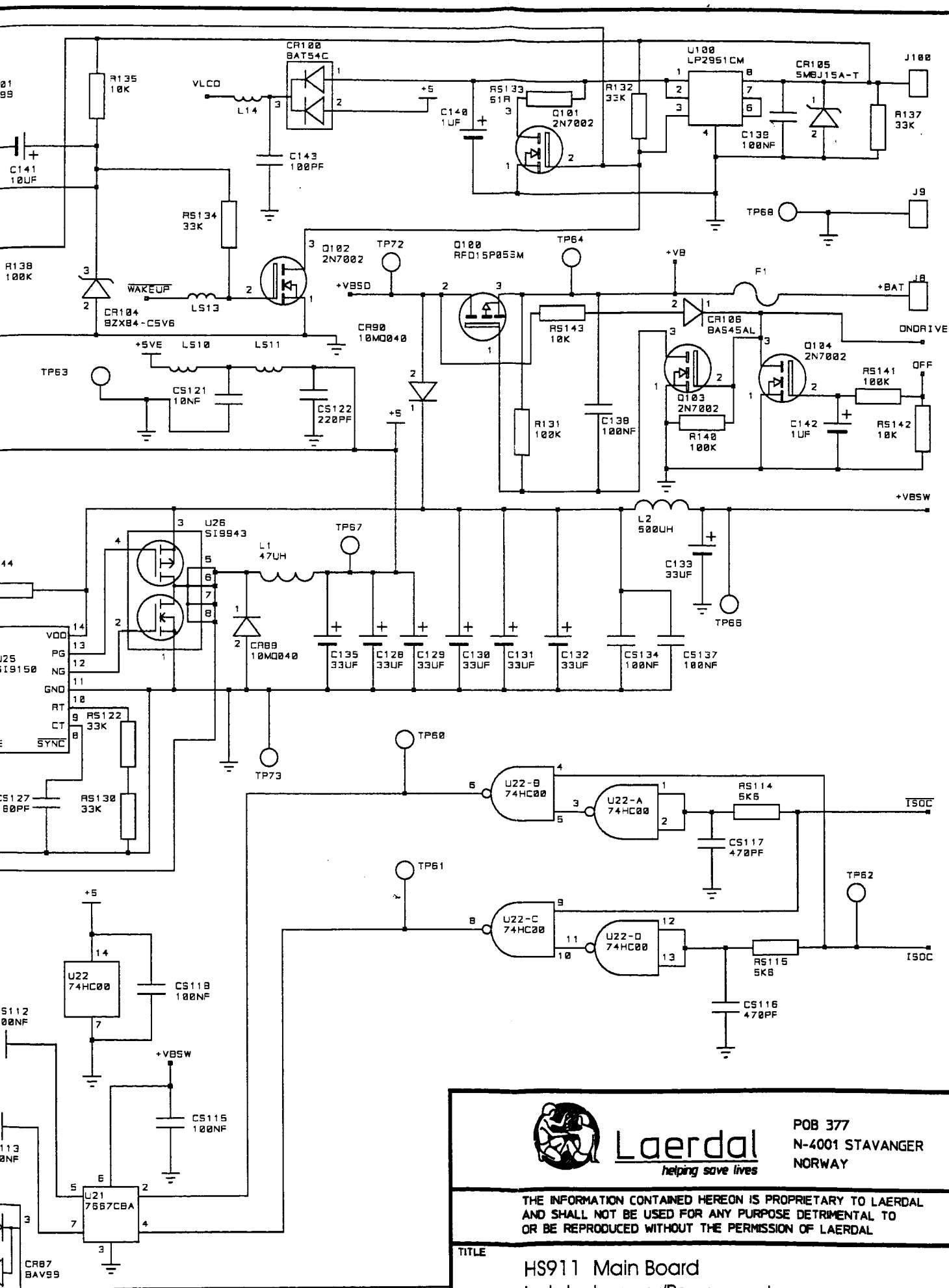
HS911 Main Board
High Voltage

File: F13284BS.CDR

Rev. B

Sheet


CR102
BAT54C
KEYON
ONDRIVE
CR101
BAV99
C141
10UF
CHRO
TESTR
RS136
220R
R138
100K
CR103
BAV99
+7V
TP69
+VCC
TP54
C120
100NF
U24
LP2951CM
R139
1K
C103
1UF
TP55
RS119
150K
CS123
10NF
R144
X
TP75
TP74
EN
STBY
U25
SS
COMP
FB
VREF
ISENSE
+5
C110
33UF
C111
100NF
C124
180PF
CS125
39NF
C126
100NF
RS121
143K
C136
100NF
CR91
BAT54S
TP70
GBTP
CR95
BZX84-C18
C102
10UF
TP71
GBTN
CR92
BAT54S
T3
ISOLATION
TRANSFORMER
TP57
CR81
10MQ040
-7V
TP58
CR82
10MQ040
CR83
10MQ040
CR85
1N4738A
BV2
+7V
CR84
10MQ040
C104
33UF
C105
33UF
CR86
1N4738A
BV2
C106
33UF
C107
33UF
C108
33UF
C109
33UF
TP59
C144
X
R110
100M
U28
SI9956
CS112
100NF
R111
100K
CS113
100NF
R112
100K
+5
RS113
10K
C114
10UF
ISOLATION BORDER



Components with value X are not to be mounted

Testpoints, TP, are not to be mounted

Laerdal
helping save lives

POB 377
N-4001 STAVANGER
NORWAY

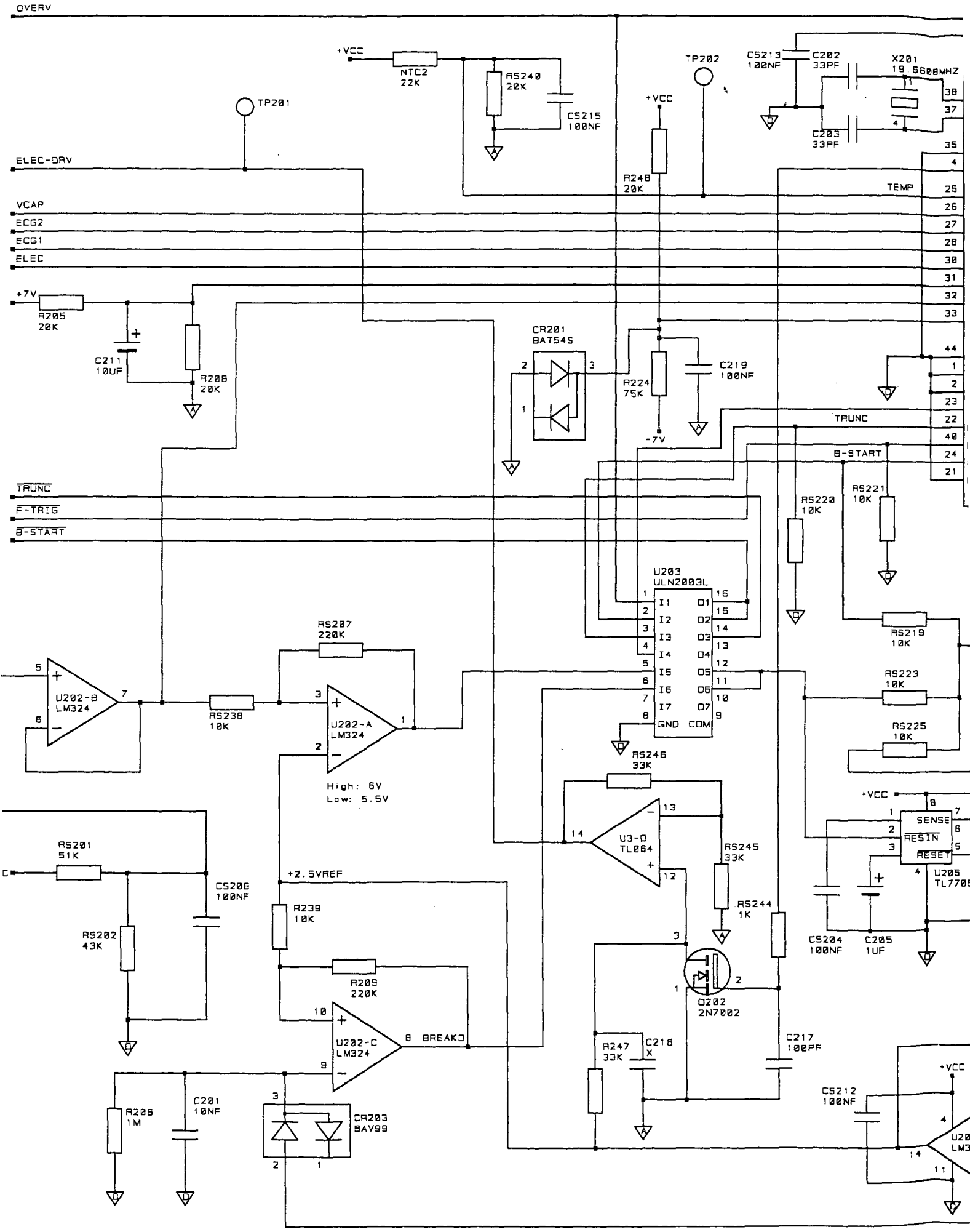
THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

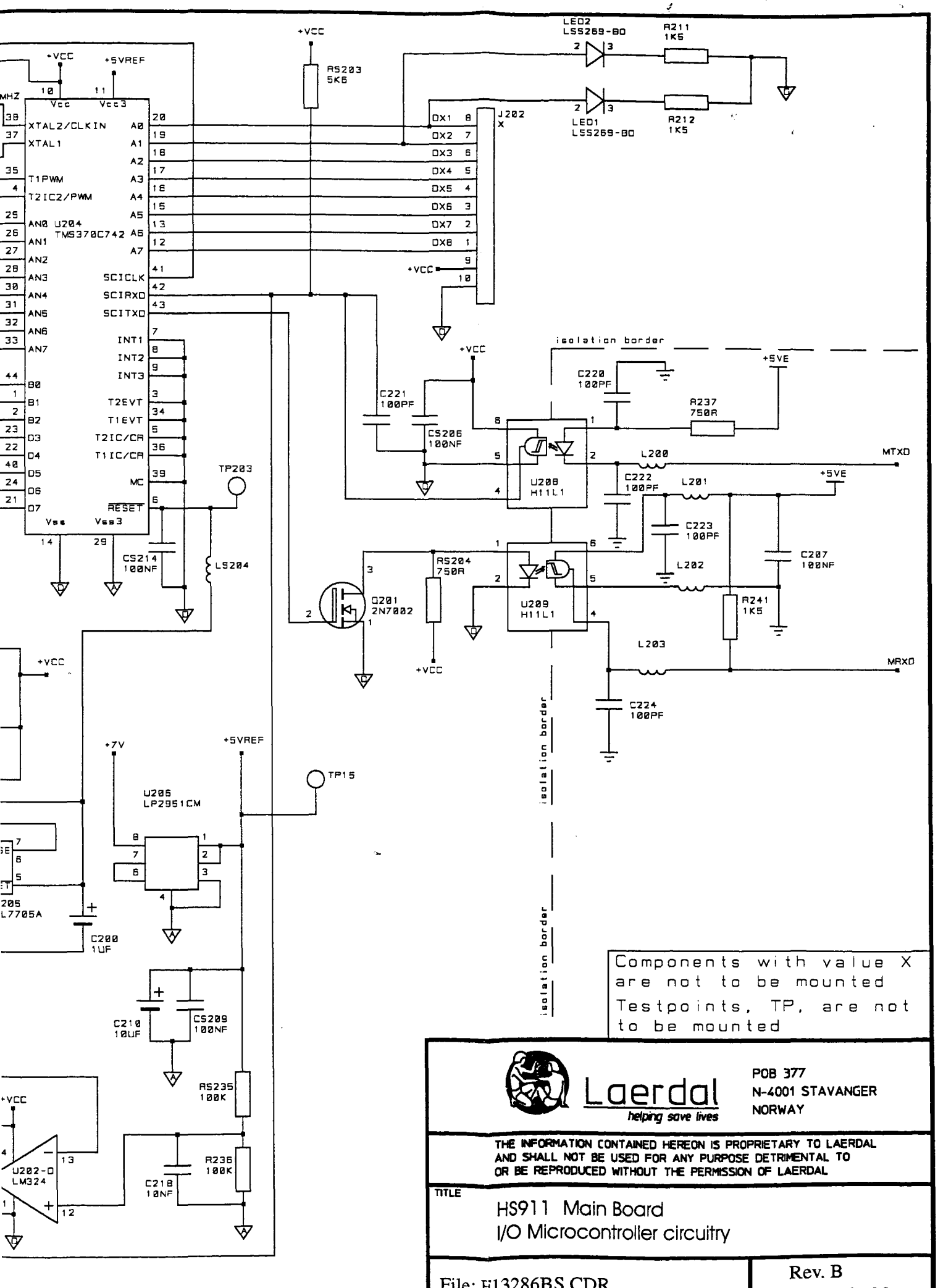
TITLE

HS911 Main Board
Isolated power/Power up-down

File: F13285BS.CDR

Rev. B
Sheet: 5 of 9


OVERV
+VCC
NTC2
22K
RS240
20K
CS215
100NF
TP201
TP202
CS213
100NF
C202
33PF
X201
19.6608MHZ
C203
33PF
ELEC-DRV
R248
20K
TEMP
VCAP
ECG2
ECG1
ELEC
+7V
R205
20K
C211
10UF
R208
20K
CR201
BAT54S
R224
75K
C219
100NF
-7V
TRUNC
B-START
F-TRIG
RS220
10K
RS221
10K
U203
ULN2003L
RS219
10K
RS223
10K
RS225
10K
RS207
220K
U202-B
LM324
RS238
10K
U202-A
LM324
High: 6V
Low: 5.5V
RS246
33K
U3-D
TL064
RS245
33K
RS244
1K
+VCC
SENSE
RESIN
RESET
U205
TL7705
CS204
100NF
C205
1UF
RS201
51K
CS208
100NF
RS202
43K
+2.5VREF
R239
10K
R209
220K
Q202
2N7002
U202-C
LM324
BREAKO
R247
33K
C216
X
C217
100PF
R206
1M
C201
10NF
CR203
BAV99
CS212
100NF



Laerdal
helping save lives
POB 377
N-4001 STAVANGER
NORWAY

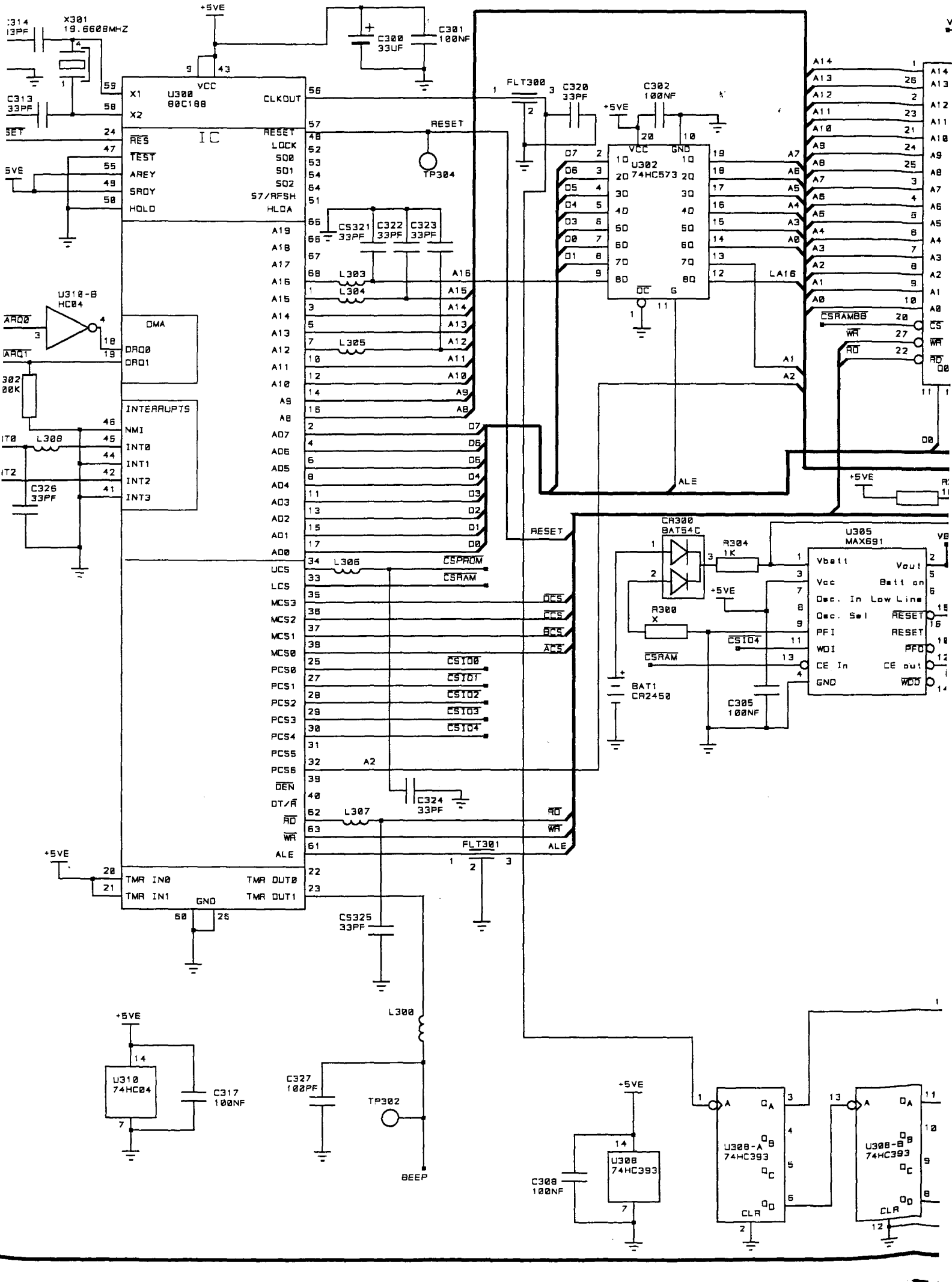
THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

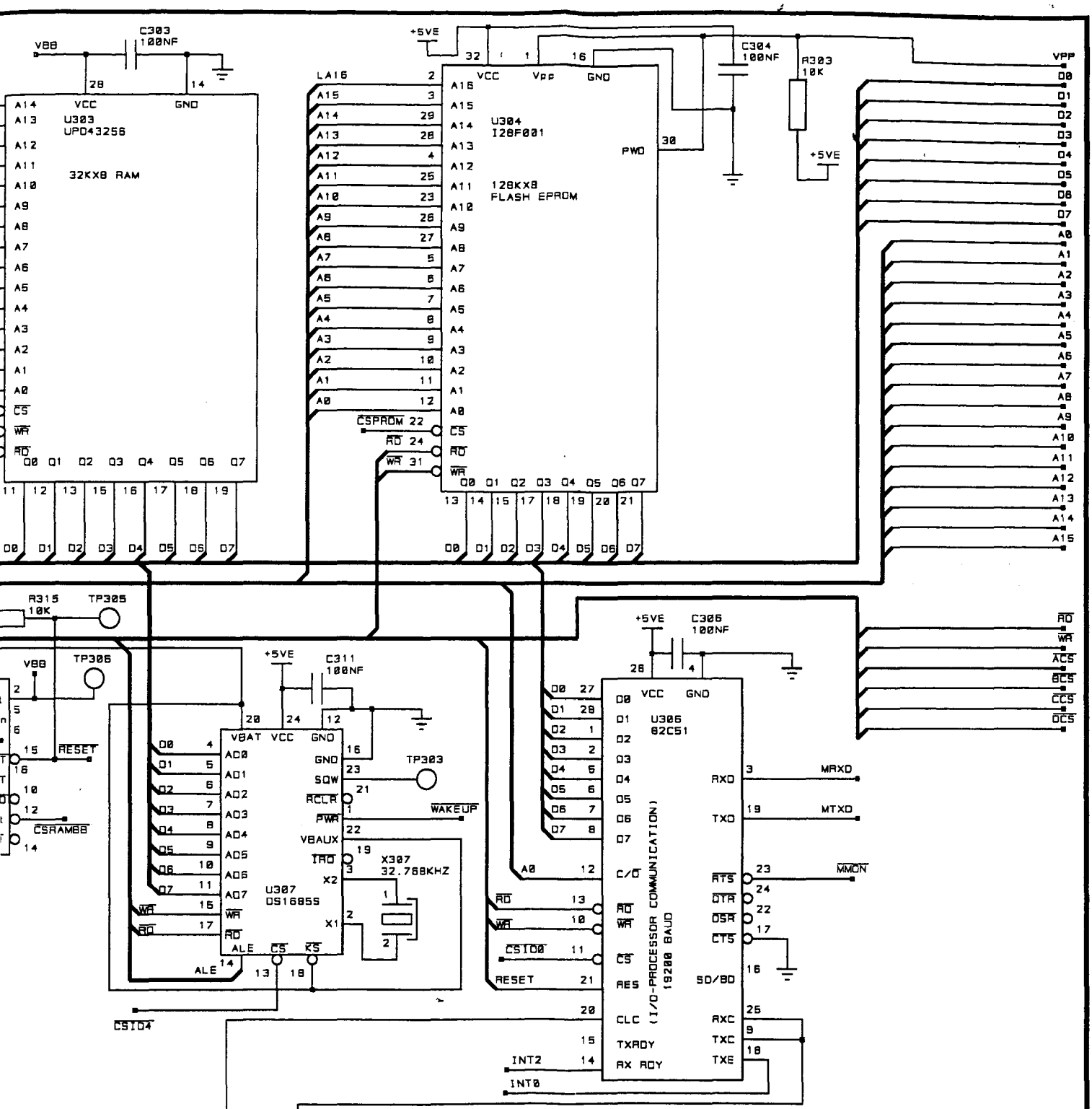
TITLE

HS911 Main Board
I/O Microcontroller circuitry

File: F13286BS.CDR

Rev. B
Sheet: 6 of 9


X301
19.6608MHZ
+5VE
C300
33UF
C301
100NF
U300
80C188
CLKOUT
RESET
TP304
FLT300
C320
33PF
C302
100NF
U302
74HC573
VCC
GND
OC
G
LA16
CSRAM88
U310-B
HC04
DMA
DRQ0
DRQ1
INTERRUPTS
NMI
INT0
INT1
INT2
INT3
C326
33PF
L308
L303
L304
L305
L306
L307
CS321
C322
C323
C324
33PF
C325
33PF
A19
A18
A17
A16
A15
A14
A13
A12
A11
A10
A9
A8
AD7
AD6
AD5
AD4
AD3
AD2
AD1
AD0
UCS
LCS
MCS3
MCS2
MCS1
MCS0
PCS0
PCS1
PCS2
PCS3
PCS4
PCS5
PCS6
DEN
DT/R
RD
WR
ALE
CSPROM
CSRAM
CS100
CS101
CS102
CS103
CS104
TMR IN0
TMR IN1
TMR OUT0
TMR OUT1
GND
FLT301
CR300
BAT54C
R304
1K
R300
X
U305
MAX691
Vbatt
Vout
Vcc
Batt on
Osc. In
Low Line
Osc. Sel
RESET
PFI
WDI
PFO
CE In
CE out
GND
WDO
BAT1
CR2450
C305
100NF
U310
74HC04
C317
100NF
C327
100PF
TP302
L300
BEEP
U308
74HC393
C308
100NF
U308-A
74HC393
U308-B
74HC393
CLR



Components with value X are not to be mounted

Testpoints, TP, are not to be mounted

Laerdal
helping save lives

POB 377
N-4001 STAVANGER
NORWAY

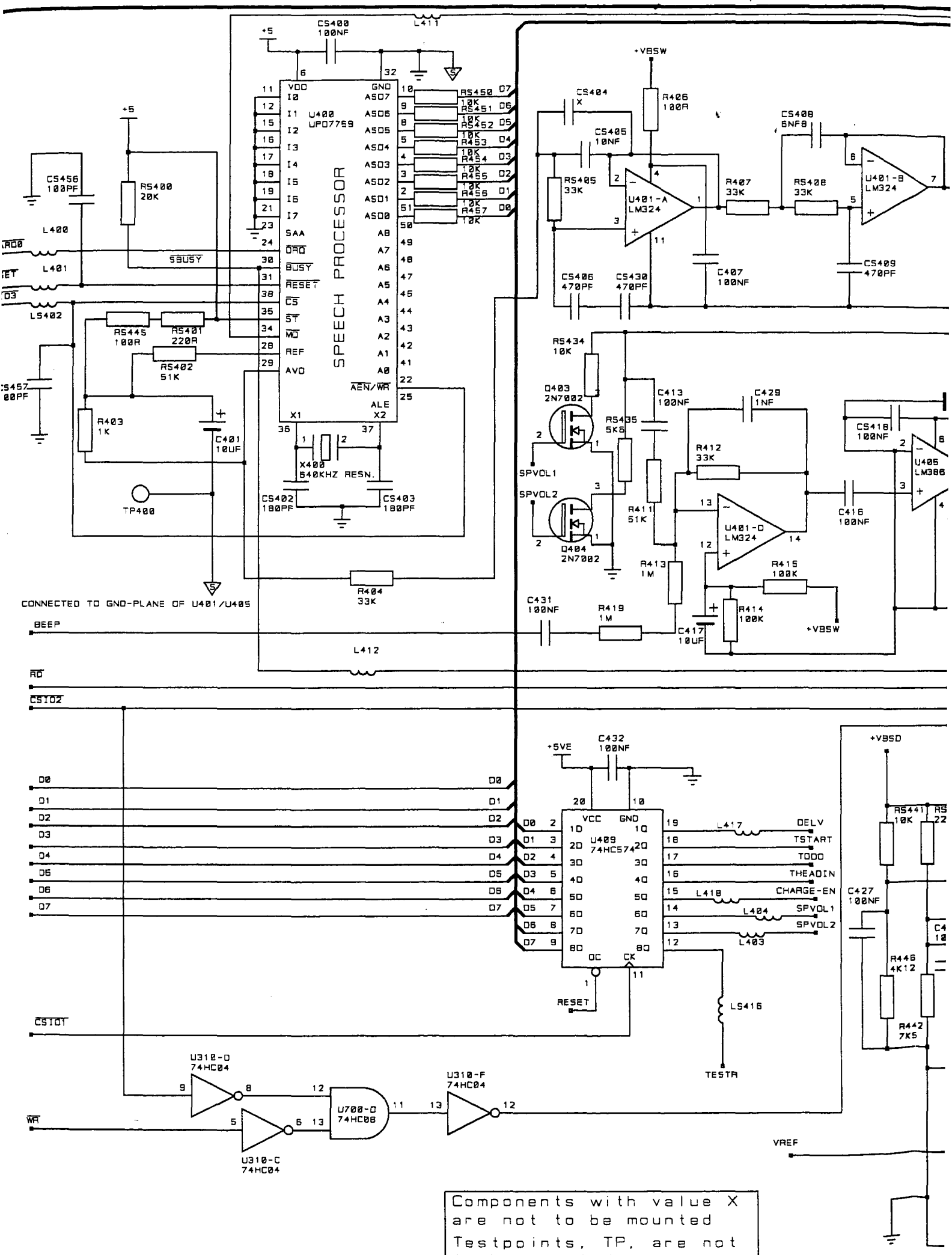
THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

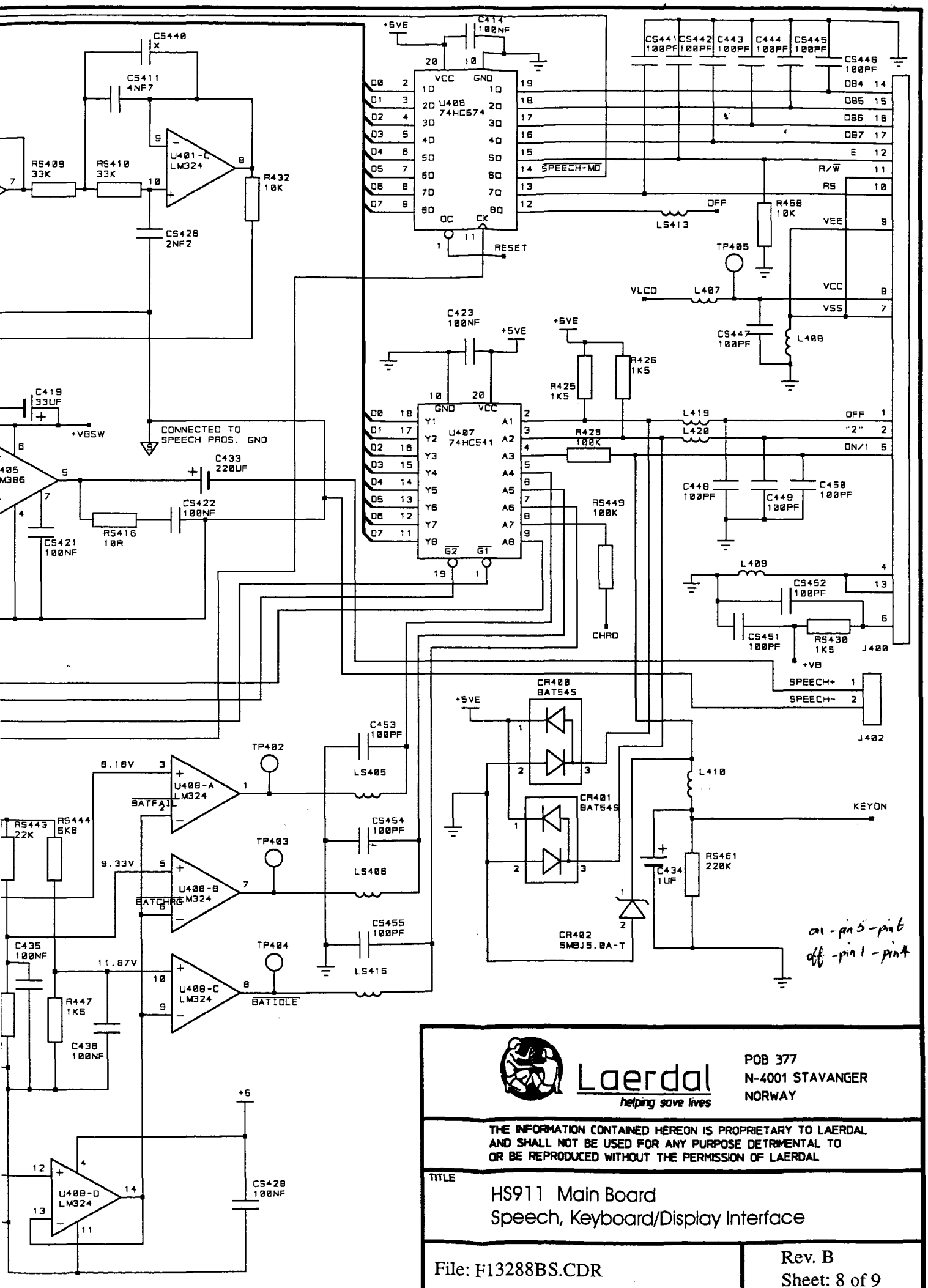
TITLE

HS911 Main Board
Main control function

File: F13287BS.CDR

Rev. B
Sheet: 7 of 9


SPEECH PROCESSOR
U400
UPD7759
CS400 100NF
L411
+5
+VBSW
CS404 X
R406 100R
CS405 10NF
CS408 6NF8
RS405 33K
U401-A LM324
R407 33K
RS408 33K
U401-B LM324
C407 100NF
CS409 470PF
CS406 470PF
CS430 470PF
CS456 100PF
RS400 20K
L400
L401
LS402
RS445 100R
RS401 220R
RS402 51K
R403 1K
C401 10UF
TP400
X400 640KHZ RESN.
CS402 180PF
CS403 180PF
R404 33K
CONNECTED TO GND-PLANE OF U401/U405
RS434 10K
Q403 2N7002
SPVOL1
SPVOL2
Q404 2N7002
RS435 5K6
C413 100NF
C429 1NF
R412 33K
R411 51K
U401-D LM324
R413 1M
R415 100K
R414 100K
C431 100NF
R419 1M
C417 10UF
CS418 100NF
U405 LM386
C416 100NF
BEEP
L412
RD
CSIO2
CSIO1
WR
D0
D1
D2
D3
D4
D5
D6
D7
+5VE
C432 100NF
U409 74HC574
VCC
GND
OC
CK
RESET
L417
DELV
TSTART
TODO
THEADIN
L418
CHARGE-EN
L404
SPVOL1
L403
SPVOL2
LS416
TESTR
+VBSD
RS441 10K
C427 100NF
R446 4K12
R442 7K5
U310-D 74HC04
U310-C 74HC04
U700-D 74HC08
U310-F 74HC04
VREF
Components with value X are not to be mounted
Testpoints, TP, are not to be mounted



Laerdal
helping save lives

POB 377
N-4001 STAVANGER
NORWAY

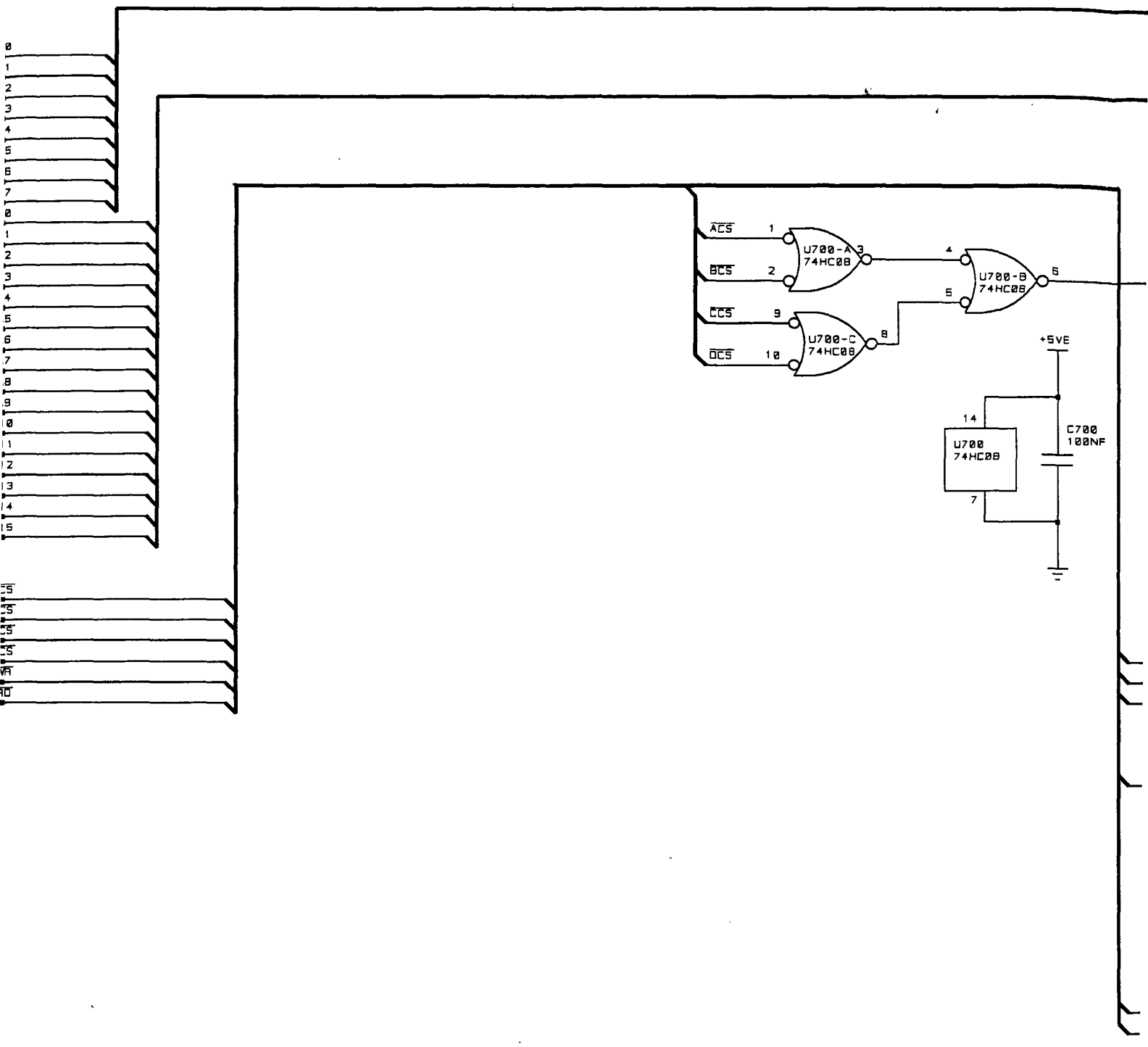
THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

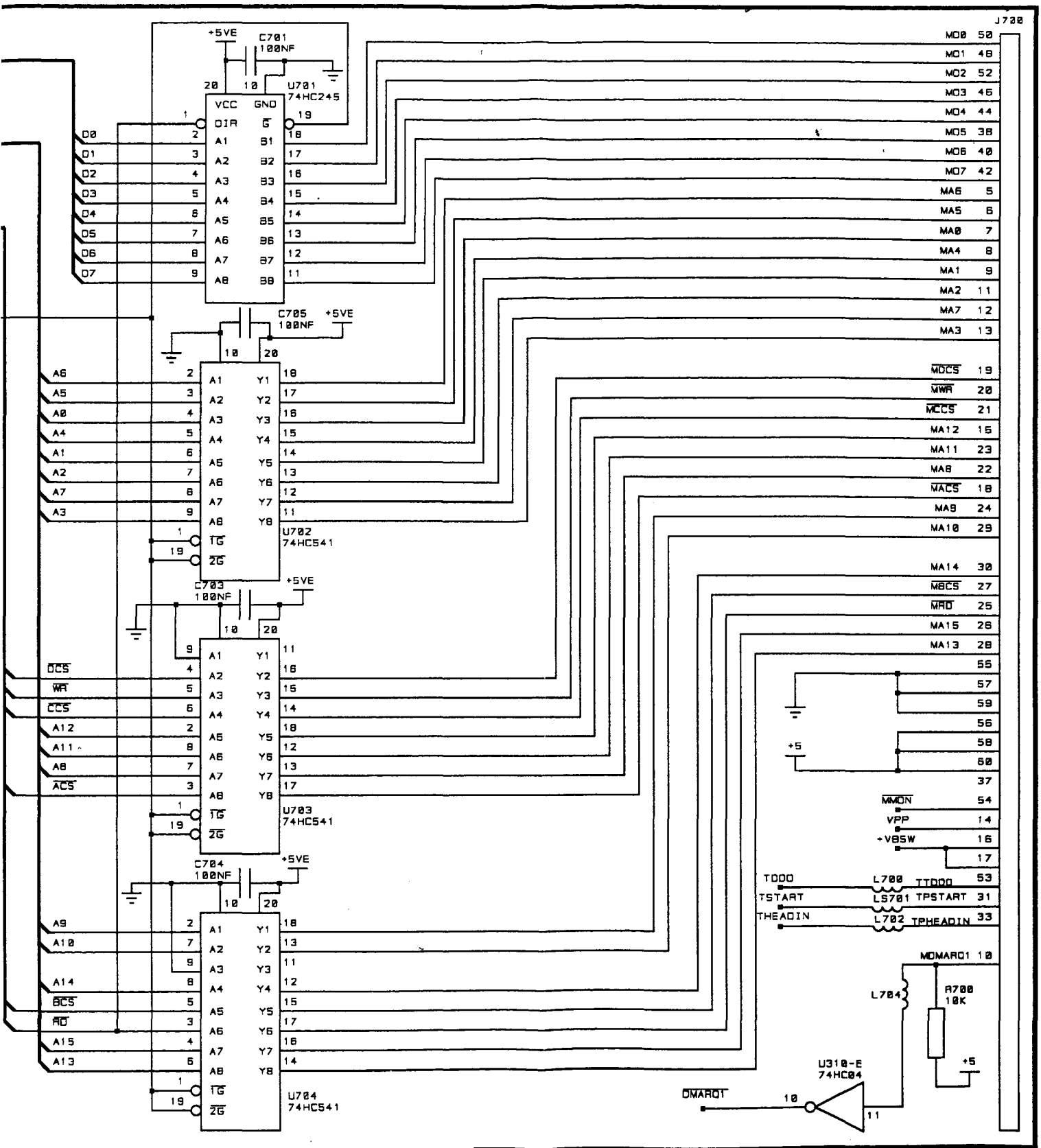
TITLE

HS911 Main Board
Speech, Keyboard/Display Interface

File: F13288BS.CDR

Rev. B
Sheet: 8 of 9


0
1
2
3
4
5
6
7
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
ACS
BCS
CCS
DCS
1
2
9
10
U700-A
74HC08
U700-B
74HC08
U700-C
74HC08
3
4
5
6
8
+5VE
14
U700
74HC08
7
C700
100NF



Laerdal
helping save lives

POB 377
N-4001 STAVANGER
NORWAY

THE INFORMATION CONTAINED HEREON IS PROPRIETARY TO LAERDAL AND SHALL NOT BE USED FOR ANY PURPOSE DETRIMENTAL TO OR BE REPRODUCED WITHOUT THE PERMISSION OF LAERDAL

TITLE

HS911 Main Board
MCM bus drivers

File: F13289BS.CDR

Rev. B
Sheet: 9 of 9